HoNESt History of Nuclear Energy and Society

D4.3: CASE STUDIES REPORTS: IN-DEPTH UNDERSTANDING OF THE MECHANISMS FOR EFFECTIVE INTERACTION WITH CIVIL SOCIETY: SELECTED CASE STUDIES

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D4.3 : Case studies reports: in-depth understanding of the mechanisms for effective interaction with civil society: selected case studies

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CAVEAT

Following the HoNESt research approach, the empirical basis of this deliverable consists of the so-called 'short country reports' (SCR) produced by HoNESt historians that are experts of the history of nuclear energy in a specific country. The aim of social science research in HoNESt Work Package 4 is to analyse these reports in terms of perception and engagement. In this process we are only occasionally able to refer to original references since these are usually not accessible e.g. for language reasons. Given this, it is all the more important to mention that, at this stage, these 'short country reports' are still in a draft status and not yet approved by the EC.

PREFACE

This document Deliverable 4.3 'Case studies reports: in-depth understanding of the mechanisms for effective interaction with civil society: selected case studies' is an update – in response to the HoNESt midterm review – of the previous version of D4.3 which was submitted in March 2017. The revision consists of four elements:

1. Update of country studies: The first issue of D4.3 had to be based on preliminary versions of HoNESt historians short country reports. In the meantime, the final draft versions of these reports are available, which offered the opportunity to amend D4.3 social science country studies in the light of the latest versions of the short country reports which, however, are not yet approved by the EC.

2. USA country study: Following the emphasis put on US nuclear developments by the midterm review, D4.3 will be enhanced by an additional country study analysing the US case.

3. State of the art: In order to improve the theoretical framework and the justification of the analytical dimensions, an extensive literature review has been done to detail the state of the art regarding public perception and engagement in nuclear issues.

4. Completing the in-depth analysis: In the first version of this report, only the phase of classification of the information could be presented (due to the lack of data in the first SCRs versions). Now, however, in the light of the complete reports, it has already been possible to carry out the complete analysis, making connections between variables and dimensions, and testing the working hypotheses arising from the literature review and the proposed theoretical framework..

EXECUTIVE SUMMARY

This deliverable (D4.3) summarizes the key findings from the selected case studies of the HoNESt project in terms of societal perception and societal engagement. Reports from eight countries were selected from a total of twenty, according to the following key criteria: geography (location), political system evolution, and degree of public acceptance. The completed analysis reveals a broad overview of how actors have perceived nuclear developments over the past decades, and which types of engagement tools and mechanisms have been used in each case studied.

According to our theoretical proposal, the perception of nuclear energy is composed of four dimensions: health & environment, economics, socio-cultural, and political-institutional. In each specific case, these dimensions may have different weights in their influence on the opinions, attitudes, or behaviours of the population and of the promoters and public authorities. In this way, we not only distinguish between proponents or opponents of nuclear energy, but are able to identify the specific dimensions that underlie actors' support or rejection of nuclear technologies. This will allow us to better explain the frequent ambivalences related to nuclear developments. Additionally, the relationships between the four analytical dimensions are not linear. Our analysis is based on the assumption that nuclear energy is a technology with different degrees of public acceptance in different countries, depending on the perceived risks and benefits (which are mostly included in the health & environment and economic dimensions). These risks and benefits depend on the social trust of the institutions in charge of managing and/or regulating it (political-institutional dimension), all of which are a function of a series of socio-cultural factors generated by the social climate over time (socio-cultural dimension).

The analysis demonstrates that the perceived risks and benefits are very similar in all the countries sampled. The most frequently mentioned risks are those related to the possibility of accidents and radiation contamination; in both cases these include damages or losses that may affect human health or the environment (especially aquatic, fluvial or marine environments). There are also concerns about the safety of nuclear facilities, as well as references to episodes of stress and anxiety in some people when confronted by the possibility of such risks materializing.

A majority of the references to health and environmental concerns related to nuclear power were reported in the period 1970-1990, although some references can also be found in other periods.

In all the countries studied, there are actors who argue that nuclear energy will bring benefits of different types, including: economic benefits (jobs, socioeconomic development, inexpensive electricity and/or a guarantee of energy supply), environmental benefits (to a lesser extent), and even benefits to human health (i.e., medical helthy uses, as reported in Michelsen & Harjula, 2017). Regarding these benefits, changes can be small and are observed over time, specifically with respect to environmental benefits. In the first two phases (1950-1970 and 1970-1990), some actors talk about the positive environmental impacts of nuclear energy production. These include temperature increases that could favour certain ecosystems and economic activities (i.e. advantatges for the farmers of the touristic destinations, as said in the Spanish case, in Rubio-Varas et al., 2017) and the fact that nuclear energy produces less pollution than other industries (as said in the Swedish report, in Kaijser 2017). However, since 1990, there are no more references of this type; and instead, more is spoken about the benefits of nuclear energy in the fight against climate change.

So, although the perceived risks and perceived benefits are very similar in all the countries studied, the social and institutional responses are very different. In order to give an answer to this enigma we first need to understand how people perceive their relationships with institutions (social trust, or what we have considered here as the political-institutional dimensions), as well as what kind of socio-cultural factors are part of the context in which the nuclear technology is perceived.

According to our analysis, the main political-institutional factors identified in the SCRs shaping social trust are the following:

- Low institutional trustworthiness, which draws attention to the fact that the behaviours of the institutions in charge of managing or regulating nuclear energy have been perceived as not worthy of trust by certain social sectors. In the SCR there are many examples of these types of behaviours generating mistrust.

- Political games (i.e. elections affected decision making, political parties changed their opinion about nuclear developments when governing, fights between pro and anti-European parties, etc.).

- Dependency of other countries conditioned decision making, leading national governments to adopt certain behaviours in order to gain energy autonomy or to avoid dependency.

The analysis found that the main socio-cultural factors shaping the perceptions of risks, benefits, and social trust are the following:

- Conflicts of values: social conflicts related to preferences for different lifestyles, different economic and social development models, different attitudes towards pacifism / warmongering that nuclear development may entail, concerns about how future generations will judge current ones because of their management of nuclear energy, etc. These are elements that respond to different ideologies or ways of understanding how society and its evolution should ideally be.

- National scientific pride (and national military pride too).

- Territorial identity conflicts (territorial comparative grievances; conflicts between economic activities and land uses, etc.).

- Subjective attributes of risk: perception of difficulty of calculating risks, perception of low controllability of risk, unwillingness of being exposed, familiarity with the technology (and coping with similar risks in the past).

These factors are also unevenly distributed among the different countries, and therefore would help to explain the different social responses to nuclear energy. The articulation of this complex set of factors in our analysis leads to the emergence of three main groups of countries:

a) Countries where nuclear energy plays a key role in national independence. This independence has conditioned both public opinion and management spheres and has led to a situation where the perceived benefits (in terms of national independence, pride, etc.) are higher than the perceived risks. Bulgaria, Ukraine, and to some extent Finland, would be part of this typology.

b) Countries where the nuclear issue was instrumentally used for political and electoral purposes, and where the behaviour of some institutions (promoters and/or public authorities) was perceived

as low trustworthiness. F.R. Germany, Sweden, and to some extent Spain, would be included in this typology.

c) Countries with higher public trust towards institutions (regulators / public authorities), conflicts between economic activities and land uses due to nuclear developments, and conflicting values related to the use of nuclear weapons and the risk of war. These countries share a strong national scientific (and military) pride, which has inevitably influenced the public perception of risks and benefits, as well as the trust in institutions. The UK and the USA would share this typology.

Regarding engagement practices and mechanisms, the analysis shows a long list evolving through the different temporal phases:

- During the first period (1950-1970), the communicative practices related to the expression of nuclear promises (popular films, etc.) predominated, but some countries also activated consultation processes (public opinion surveys in UK, USA, Finland) or participative mechanisms (public meetings in the UK, a study group in Sweden). These countries were facing public opinion pressures due to earlier incidents (Windscale in the UK, Fermi in the USA) and/or nuclear weapons debates.

- In the second period (1970-1990) communicative strategies continued, but also cases of secrecy and misinformation related to nuclear incidents and accidents appeared (i.e. the case of Chernobyl was poorly handled in communicative terms by public authorities in Bulgaria and Ukraine, with restricted and biased information). But the most relevant engagement activity during this phase is the increase of consultation activities, especially through public opinion surveys (that became periodic in most of the countries), information centres and meetings (as in Ukraine or Sweden) or even referenda (done in Sweden, and proposed in some states of the USA). In the UK, the public inquiries mechanism played an interesting participative approach. Public-initiated engagement rose dramatically during this period in all of the countries (the SCRs refer to mass mobilization protests, collected signatures, press interventions, etc. from local communities and national social movements).

- The third period (1990-2015) is characterised by an intensification of the consultation mechanisms: public opinion surveys, referenda (mainly at the local level, in Bulgaria, Sweden, and Ukraine), participative processes as public hearings (in Ukraine and Sweden), local informative committees, local joint commissions (Spain), voluntary candidature processes to siting nuclear installations (as in Sweden and Spain), citizen's panels (UK), etc. Regarding communicative mechanisms, during this phase Internet began to play a key role in transmitting information to the public, allowing more transparency and accountability of the nuclear sector, and also being used for consultative purposes.

Finally, the analysis shows how each of the countries' typology is broadly related with different engagement processes over time:

- The 'institutional confidence' countries (UK and USA) seemed to be the first in promoting communicative strategies to cope with early nuclear incidents, and to spread (broadcast) the benefits of nuclear development among the public. Progressively, they developed consultative strategies to measure public opinion over time, while introducing participative mechanisms to deliberate and collect the diversity of voices and points of view on nuclear issues at both a local and national level. In general, most of these strategies seemed to be applied in a pro-active way (more in the UK than in the USA).

- The 'political instrumental' countries (F.R. Germany, Spain and Sweden) started later but followed the same path. They introduced processes and mechanisms that were progressive, communicative, consultative, and participative, but mainly in a re-active way. These countries were trying to cope with the massive protest against the nuclear siting of developments. Perhaps Sweden was somewhat different because the idea of national scientific pride and modernization was actively present in the public debate on nuclear issues.

- The 'national independence' countries (Bulgaria, Finland and Ukraine) also followed the same path. This path was especially needed since they had to manage information and public opinion protests after the Chernobyl accident. Distrust in how the public authorities and nuclear promoters managed this serious situation was later balanced by the consideration of nuclear energy as something necessary for national sovereignty, leading to a kind of resigned acceptance mixed

with national pride. The case of Finland is perhaps slightly different than the other countries because trust in Finnish institutions has remained quite high throughout the nuclear period.

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1. Introduction

This deliverable (D4.3) summarizes the key findings from the selected in-depth case studies of the HoNESt project in terms of societal perception (public perceptions, reactions, social movements, etc.) and societal engagement (actors, practices, mechanisms, etc.).

This report is based on HoNESt deliverable D4.2 which described the key factors underlying societal perception and engagement with nuclear development in selected European countries. D4.2 used a systematic approach to scrutinize a series of country reports using an overall evaluation framework for the analysis of historical narratives of nuclear developments and outstanding events related to the use of nuclear energy. Moreover, the validity of our concepts about public perception and public engagement in different national nuclear environments were tested.

Analysing and selecting the relevant Short Country Reports (SCRs) helped us identify which kinds of concepts and indicators were most useful in describing and understanding the available data. In the present deliverable, D4.3, we have updated and reclassified the theoretical concepts in order to better describe and understand the key factors underlying public perceptions and engagement actions.

For the present analysis, eight in-depth country reports were selected from a total of twenty. We adopted a pragmatic approach, the selection was made based upon the following key criteria:

- Geography (a balance of different locations across the European cases)
- Exploring different political systems, cultural and democratic norms.
- Different levels and types of public acceptance and social movements of opposition

Resulting from the selection, the following eight countries are reviewed based upon these simplified criteria in Table 1:

Table 1 - Country Sample

Country	Geography (location)	Political system	Public Acceptance
Bulgaria	East Europe	Soviet regime + Democracy	High
Finland	Scandinavia	Democracy	High
F.R. Germany	Central Europe	Democracy	Low
Spain	Mediterranean Europe	Dictatorship + Democracy	Low
Sweden	Scandinavia	Democracy	Medium
Ukraine	East Europe	Soviet regime + Democracy	Medium
United Kingdom	West Europe	Democracy	High
USA	North America	Democracy	Medium

Source: own depiction

2. Theoretical definitions on 'public perception' and 'engagement'

The central objective of HoNESt is to identify and analyze the core explanatory factors of societal interaction with nuclear applications, based upon the historical data. This interaction – described in what follows as 'nuclear-societal relations' – includes three closely interrelated components:

- Perception: It is crucial to identify and assess the importance of the factors underlying the societal perception of nuclear developments.

- Civil society's engagement with nuclear energy: Such perceptions have significantly motivated civil society's varying engagement with this technology (from implicit or tacit support to active opposition). It is important to consider that citizens and civil society groups also played an active role in engaging with the technology.

- Policy-makers' and industry's engagement with civil society: This is the main focus of the study: How did industry and policy makers – among other relevant actors – try to engage citizens and civil society? The goal here is to examine the different mechanisms and instruments used to

engage with society, in order to arrive at recommendations for an affordable, secure, and clean energy production.

Nuclear-societal relations are embedded – and this is the core assumption underlying this research project – in complex historical, political, economic, societal and cultural contexts. Only by taking seriously the varying importance of these contexts throughout time and space, it will be possible to understand controversies around nuclear energy, why these differ across countries, and what can be done to adequately engage society.

We will describe here how the literature has addressed the study of public perception of technological risks in general, and of nuclear energy in particular, in order to identify the main underlying dimensions and their interrelationships with public engagement strategies and mechanisms. Grounded in these dimensions we have developed a theoretical model which will allow us to analyse the selected Short Country Reports. This model includes perceived benefits and risks of nuclear energy, societal trust in institutions, and other related socio-cultural, psychosocial, moral and political factors. Later we will relate these findings with several public engagement strategies.

2.1. Public perception

When defining public perception concepts, the same basics as established in deliverable D4.2 have been followed. In that process, we learned how to better adapt our framework to ensure that most of the relevant data of the country reports were properly gathered and interpreted.

Public acceptance and/or opposition to nuclear technologies reveal interplay between numerous complex factors influencing and shaping perceptions and values. These include factors such as institutional trust, procedural fairness, risk tolerability, availability of scientific information, and – most recently – nuclear power's role in mitigating anthropogenic climate change (Besley, 2012; Parkhill et al., 2010; Pidgeon et al., 2008; Poortinga et al., 2006; Visschers/Siegrist, 2012). Such complex factors go beyond simple direct interactions with government and the nuclear industry and reflect a spectrum of interactions within local communities and within wider society (Whitton

et al., 2016). These complex factors can be traced in the main theoretical approaches of social theories of risk, such as the psychometric paradigm (Slovic 1993, 2000), affective approach (Slovic and Peters, 2006), the cultural theory of risk (Douglas & Wildavsky 1982), the interpretative (Horlick-Jones et al. 2009, 2012; Wynne 1996) and the governance approaches (Renn 2008). Taking into account the experience of the inductive exercise involved in producing the D4.2 deliverable, all these factors have been integrated here in an updated analytical framework.

In D4.2, we identified eight categories for evaluating public perceptions of nuclear energy: trust, national economics, consumer economics, local impact, environmental impact, social & ethical impact, health impact, and risk of catastrophic accident. Furthermore, we analysed public perceptions from just one actor category: *the 'receptors' (or affected people*). In order to include also the perceptions from other categories of involved actors in nuclear interaction contexts (such as the 'promoters' and the 'regulators'), we have further developed our framework and re-classified our conceptual categories into four general dimensions: health & environment, economics, socio-cultural, and political-institutional (see below).

These conceptual assumptions, i.e. our integrated theoretical framework, allow us to better distinguish the structure of the perceptions of the actors related to nuclear energy. In this way, we not only distinguish between proponents or opponents of nuclear energy, but also are able to identify the specific dimensions that underlie actors' support or rejection of nuclear technologies. This will allow us to better explain the frequent ambivalences related to nuclear developments, such as when (for example) an actor agrees that nuclear energy constitutes an economic benefit while at the same time, considers it unacceptable because it imposes threats to certain local identities, is linked to undesired uses of the territory, or because of a lack of trust in the managing institutions. This analytical approach could be very useful to better understand actors' perceptions, and therefore to better understand the engagement activities in which they are involved.

2.1.1. The research on public perception of technological risk

Research on public perception of risks first appeared and developed in the 1970s, and responded to the increasingly urgent need to understand and mitigate public protests about certain industrial activities and technologies (such as nuclear energy, waste disposal sites, etc.). Priority was given to identifying what kind of perceptions of risk people have, in order to be able to make decisions aimed at reducing the differences of opinion between members of the public and experts (and political and industrial managers). Much of the voluminous literature on risk perception and risk communication has addressed the differences between expert and lay assessments of the potential impacts of environmental and technological hazards. Though the evidence for differences of perceived risk magnitude between these groups is mixed (Flynn et al., 1993; Rowe and Wright, 2001). Where differentials in risk perception are prevalent, it is also notable that some hazards fail to motivate protective behaviour despite official warnings (e.g. Krimsky and Golding 1992, Pidgeon et al. 2003), – thus we can understand risk perception as being based upon a range of different factors, not simply a rational assessment of the likelihood of harm. This is because individual psychological components such as the systematic biasing of risk information, the use of mental shortcuts (heuristics), and the way that risk information is presented, interpreted and understood can influence the public perceptions (Williamson et. Al, 2005),. Yet, despite an academic understanding that risk messages are interpreted through heterogeneous understandings, biases and heuristics, there is a persistent underlying logic amongst many technical and policy authorities to try and influence lay actor behaviour towards risk by assuming that 'people would behave responsibly if only they knew the facts' (Horlick-Jones & Prades, 2009) – that risk perception is a matter of information or knowledge deficit (Sturgis and Allum, 2004).

This deficit risk communication model led to the introduction of the concept of acceptable risk, which served to indicate the threshold on the basis of which people, in line with experts, could make a rational calculation of costs and benefits, and thus encourage them to stop opposing certain technological installations. Starr (1969), who is usually cited as the initiator of this economically grounded research perspective, carried out studies on the social acceptability of different sources of risk and developed a method of evaluation of the accepted level of risk in relation to the benefits produced by the technology. With this proposal, Starr tried to offer

scientific bases to establish normatively acceptable risk thresholds that could be used in the decision making process. From the observation and verification of what people do, he deduced a series of preferences, and supposed that society is able to achieve an optimum balance between the risks and benefits associated with each activity or technology.

This proposal had soon been questioned from the field of cognitive psychology, leading to a series of research strategies that would later come to be known as the psychometric paradigm, one of the most prominent perspectives in the study of public perceptions of risk. This research strand aimed to resolve the methodological and conceptual deficiencies of Starr's proposal by identifying people's preferences on the basis of empirical data and controlled experiments, in order to find out the various attributes of risks that make people give them a greater or lesser weight (Fischhoff et al. 1978; Slovic et al., 1982, 1984; Slovic 2000). Grounded on the tradition of cognitive psychology and the theories of rational decision-making, the psychometric paradigm incorporates a multidimensional concept of risk in which the possible consequences of a risk are not only physical damage, but also other aspects including (amongst other components) psychological harm, fear and social loss. Psychometric studies revealed that people include into their judgments other elements beyond strict scientific data, thus divergences between expert assessments and lay perceptions did not have to do only with ignorance of probabilities and magnitudes of risk (as they have been defined by scientists). The research focused on discovering other elements or attributes of risk, and developed a taxonomy that could be used to understand and predict how society responds to risks (Slovic et al., 1984). The results of their empirical work have, for example, shown that, contrary to what Starr proposed, there is little correlation between risks and the benefits received. On the other hand, while Starr concluded that the voluntary nature of risk exposure was key to the acceptance of risk, psychometric paradigm research has shown that there are other equally influential factors. Thus, for example, Fischhoff et al. (1978) found that several basic attributes of risk could be reduced to two dimensions. One dimension discriminated between high- and low- technology activities, with the high end being characterized by new, involuntary, poorly known activities, often with delayed consequences. The second dimension reflected the certainty of death given that adversity occurs. Consideration of these two factors in addition to perceived benefit made acceptable risk judgments relatively predictable. However, in contrast to what had been suggested by Starr, correlations between the

acceptance of risks and the benefits perceived are more ambiguous, indirect and complex than expected.

The other dominant strand of risk perception research during the last decades had been the so-called cultural theory. The cultural theory 'grid-group' school (Douglas 1992) had sought to understand risk perception and risk-related behaviour in terms of the lifestyles (or, more accurately, the cultural allegiances) of those doing the perceiving. Anthropologists and sociologists have observed that various social and cultural groups differ regarding the importance they attach to particular risks, and they develop attitudes and behaviors that correspond to those ways of understanding the risks. The contributions of cultural studies on risk (Douglas & Wildavsky, 1982; Dake, 1991; Rayner, 1990, etc.) aim to explain this phenomenon by combining structuralist and constructivist theoretical approaches. From this perspective, beliefs, attitudes and values shared by certain groups (institutions, social groups, cultural groups) are considered to affect the selection of what they perceive to be a risk, and, therefore, people will be especially concerned about those events or aspects that mostly can affect or endanger their belief and value systems, their way of understanding and enacting their social relationships. With these assumptions in mind, the intention of the cultural theory of risk is not so much to focus on what risks people fear to a greater or lesser extent, but rather to find out what kind of social groups are concerned about certain risks and why.

Douglas (1996) posits that risk perception research has been preoccupied with a focus upon individuals rather than institutions. From this theoretical standpoint, assumptions about environment and risks are supposed to be constructed (and selected) socially with the implicit purpose of maintaining group or institutional coherence (of maintaining models of predominant, or ideal social relationships). The systems of beliefs are seen as tacit expressions of the dominant social values and serve to construct social structures that are presented to individuals as if they were natural and inevitable. Institutions (or groups) select and use risks to control the uncertainty of human behavior, reinforcing the rules and facilitating internal coordination of the group. According to Douglas (1996), the threat of a catastrophe fulfils the function of activating certain mechanisms to renew the commitment of the members with the objectives of the organization, playing thus a role in the definition of social identities.

Both psychometric and cultural theory perspectives have faced a number of conceptual challenges, whilst empirical attempts to explore the interface between these approaches have produced interesting, if mixed, results (e.g. Marris et al. 1996, 1998, Sjöberg 1997, Slovic and Peters 1998).

During recent years, greater emphasis has gradually been put on perspectives of a more integrated nature that, besides individual risk perception factors and lifestyles, also consider the social, political and cultural contexts in which processes of the perception and communication of risk occur (Horlick-Jones & Prades 2009; Wynne 2005; Renn 2008). So, for example, Otway and von Winterfeldt (1982, 1992) demonstrated that differences in perceptions of risk between individuals belonging to different social groups have a great deal to do with the existence of different beliefs about the technology or activity that generates the specific risk, beliefs that they consider to be integrated in broad systems of values through which the various groups attempt to maintain consistent social identities.

In relation to this, some scientists have studied lay understanding of technological risks in the context of their development and application. Irwin, Walker and Simmons (1999) proposed that, rather than presenting local knowledge as fixed or separable from cultural practices, places and social world views, it is better to examine the relational and active construction of risk understandings, emphasizing the significance of such factors as local memory, observation and evidence, definitions of expertise, risk and credibility, and moral discourses. The perception of risk and benefits takes place in concrete contexts of everyday life, full of power relations, symbols, etc., that can influence such perceptions. Examining this theme in greater depth, Wynne (1980, 1989, 1992, 1996, 2005) suggested that the social perceptions of and responses to risk were not so much directly related to perceptions or evaluations of any objectively existing object, but rather to the relationships that people maintained with the institutions responsible for the management of said risk.

As expert estimations of risk contain many and high levels of uncertainty, it is perfectly rational for people not to limit themselves merely to these when evaluating the magnitudes of risks. In short, perceptions of risk imply some element of judgement about the quality of the institutions involved, which is where Wynne (1996) argues the institutional dimensions of risk become relevant. In

other words, dimensions such as the trustworthiness of an institution (responsible for managing a risk), the existence of dependent relationships with that institution, its (perceived) independence with respect to other social agents, the perceived justice of its actions, its (perceived) legitimacy, its (perceived) competence, etcetera, become important criteria.

From a social interpretativist approach, the categories of 'expert' and 'lay' people are problematized drawing upon hermeneutic and phenomenological traditions; perspectives which recognise the central roles of meaning and interpretation in structuring social interaction and being (Horlick-Jones & Prades, 2009). Beck's and Giddens' Risk Society (or reflexive modernisation) Model (Beck et al. 1994) gave a fitting general sociological framework to the rise of these institutional and interpretative approaches. However, although these approaches provide interesting insights, serious questions exist about their capacity to capture the full diversity of risk-related practices that may be observed in real-world settings.

A broad sociological literature providing evidence of situationally-specific logics entailed in risk reasoning and practice across a range of organisational and social contexts has been emerging and should be taken into account in this context (Lupton 1993, White 1999, Jaeger et al. 2001, Prior 2001, Candlin and Candlin 2002, Espluga et al. 2009, 2014, Lupton and Tulloch 2002, Maynard 2003, Horlick-Jones 2003, 2005a, 2005b, 2007, Horlick-Jones et al. 2007, Myers 2007, Poumadère 2016, Prades López et al. 2008).

Renn's work (2005, 2008) proposes a broad integrative governance approach, trying to take advantage of both a more contextual understanding of risk and a more traditional technical and analytical approach to risk (Klinke and Renn, 2002). From this perspective, public perception of risk is conceived as a selection process guided both by cultural values and institutional order, and also by systematic and technical-scientific reasoning (such as probability theory estimating damage potential and distribution). Thereby risk is conceived as constituted by both physical/material and social/cultural elements. The underlying argumentation is grounded on the assumption that although it is analytically possible to separate values and evidences, social norms and factual knowledge, analysis and deliberation, in practice there is a need for better integration of these separate entities. From this perspective, social science and natural science need to cooperate better and researchers and lay people need to cross-fertilize their different

understandings of risk, and Renn's work is therefore devoted to finding a way that integrates different kinds of knowledge – namely an analytic-deliberative approach that brings together competing knowledge perspectives from technical and non technical actors (Renn, 1999).

2.1.2. A conceptual model of factors underlying public perception of nuclear power

The different perspectives of analysis depicted above respond to different theoretical and methodological (even ideological) positions, which are not always compatible with each other, but that have generated a strong body of knowledge useful to be used in understanding public perceptions and responses to technological risk. Most of these theoretical perspectives have been applied to the study of nuclear energy, showing how many of the mentioned factors influenced the public perception on this issue. So, a first phase of risk research from the 70's to the 90's of the past century focused on the factors underlying social responses to nuclear energy in general (and the proliferation of nuclear weapons), and towards the siting of nuclear plants in particular (i.e. Rothman & Lichter 1987).

Based upon the analysis of the literature on nuclear perceptions, in what follows we will be suggesting a conceptual model of the factors and their interrelations shaping the public perception of nuclear power. As a first step, we shed light on main theoretical assumptions to be derived from the literature on nuclear perceptions:

1. The degree of public acceptance (or toleration) of nuclear energy issues is mainly related to the perception of certain types of benefits and risks.

2. The perception of risks and benefits is strongly influenced by the degree of trust that people have in the institutions and companies promoting and regulating nuclear power and sites.

3. At the same time, both benefit/risk perceptions and social trust are influenced by a set of antecedent variables including affective feelings, 'affective imagery', values or beliefs and ideological and political orientations (e.g. pro-environmental ideological orientation). In addition, the conformation of previous attitudes towards nuclear energy tends to condition the possibility of changing these in the future, since a certain psychosocial inertia is a familiar phenomenon.

These assumptions can be combined to a theoretical model that is graphically represented in Figure 1.

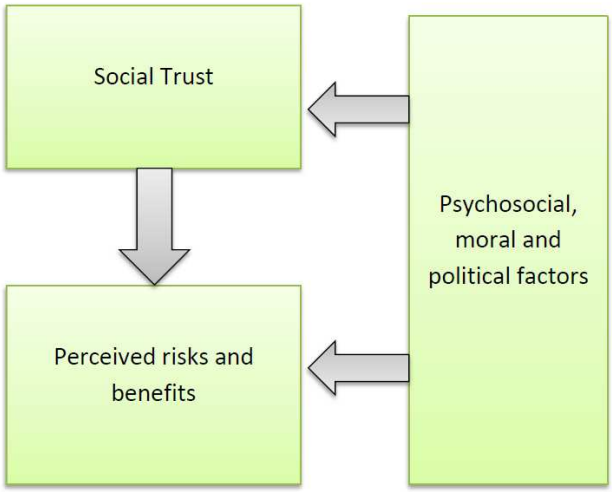

Figure 1: Factors influencing public perception on nuclear power issues. (Source: own depiction based on literature analysis)

In the following we will discuss how the nuclear perceptions literature has defined and implemented the elements of the model.

a) Perceived benefits / risks

It is difficult to define what 'counts' as a risk or benefit of nuclear energy, and to separate these two characteristics. The same factor can display both at the same time. For example electricity supply can be understood as an obvious benefit and as a shortage risk (if there are no nuclear plants). Similarly, governmental investment in new nuclear plants is simultaneously a community financial benefit from job creation, and a tax-payer liability – it is both benefit and risk at the same time.There is, therefore, no clear relationship between the perception of benefits and of risks. For instance, significant correlations between perceived benefit and perceived risk have been found in the literature (Alhakami & Slovic, 1994; Frewer et al., 1998; Gregory & Mendelsohn, 1993), but the opposite has also been found by other scholars (such as Siegrist, Cvetkovich & Roth, 2000). This may indicate that relationships between the perception of benefits and of risks could be a

context-dependent issue of each case studied. Moreover, When it comes to risks, we can understand them as often being transferred between types, locations or temporal scales. A new nuclear power station may for example transfer energy generation risks away from a community living with a coal-powered production facility, or reduce the long-term risks associated with anthropogenic climate change, whilst increasing potential radiation exposure risks to current or future generations from accidents or long-term spent fuel storage (Shrader-Frechette, 2000). Whether nuclear power is perceived as socially beneficial is therefore dependent (in part) upon framing effects in language (Barthe, 2009; Renzi, Cotton, Napolitano and Barkemeyer, 2017) – language influences the ways in which problems are constructed and presented to public actors, alongside technical and policy actors.

The main types of benefits and risks related to nuclear power identified in the literature could be classified in the following categories:

- Energy supply: Risk and benefits of nuclear energy relate to the capacity (or not) of covering energy needs (Keller, Visschers & Siegrist, 2012) and of guaranteeing continuous and sufficient electricity supply (Kılınç, Boye & Stanisstreet, 2013; Visschers, Keller & Siegrist, 2011; Corner, Venables, Spence, Poortinga, Demski & Pidgeon, 2011). Potential energy shortages are also considered as a perceived risk in some studies (Stoutenborough, Sturgess & Vedlitz 2013). The relative advantages and disadvantages of nuclear energy compared to other alternative energy options are mentioned by some scholars (Li, Brossard, Anderson, Scheufele & Rose 2016). The debate about the energy consumption levels and the convenience of reducing these is also present in the literature (Löfquist 2015).

- Economic growth: Benefits and risks of nuclear power are related also to countries' (and companies') economic growth, emphasis on economic priorities (Van der Pligt, Eiser & Spears, 1984) and nation's prosperity (Ylönen, Litmanen, Kojo & Lindell, 2017). Economic losses due to nuclear programs are also mentioned (Siegrist, Cvetkovich & Roth 2000).

- Safety issues: Some scholars focus on safety as a factor underlying positive attitudes towards nuclear power (Elam & Sundqvist, 2009; Ylönen, Litmanen, Kojo & Lindell, 2017), in other cases accidents are reported as a key factor in changing attitudes (Keller, Visschers & Siegrist 2012). In fact, there is a large amount of data showing that acceptance of nuclear power decreased after the Fukushima nuclear accident. (Huang, Zhou, Han, Hammitt, Bi & Liu 2013). Risk of terrorist acts has also been taken into account in some studies (Kim, Kim & Kim 2014)

- Environment and health effects: Health impacts on living organisms, including humans, living nearby (Kılınç, Boye & Stanisstreet 2013), and environmental impacts are considered here (Siegrist, Cvetkovich & Roth 2000) (Keller, Visschers & Siegrist 2012). In fact, some studies show that governmental stakeholders are primarily concerned with the environmental and local impacts of nuclear fuel cycles. (Li, Brossard, Anderson, Scheufele & Rose 2016). Besides, concerns related with the radioactivity potentially released (and its correlative chronic health and environmental risks) are reported by some studies (Keller, Visschers & Siegrist 2012).

- Environmental benefits: The potential contribution of nuclear energy for climate change mitigation is widely analysed in recent risk perception literature (Visschers, Keller & Siegrist, 2011; Pidgeon, Lorenzoni & Poortinga 2008; Corner, Venables, Spence, Poortinga, Demski & Pidgeon, 2011). In fact, acceptance is mainly influenced by perceived benefits for a secure energy supply, and, to a lesser extent, by perceived benefits for the climate (Visschers, Keller & Siegrist (2011). But some studies show that people see both climate change and nuclear power as problematic in terms of risks, and express only a 'reluctant acceptance' of nuclear power as a 'solution' to climate change (Pidgeon, Lorenzoni & Poortinga 2008). While higher proportions of the public are prepared to accept nuclear power if they believe it contributes to climate change mitigation, this is a highly conditional view, with, given the choice, very few actively preferring this over renewable sources (Corner, Venables, Spence, Poortinga, Demski & Pidgeon, 2011). However, when nuclear power was given an explicit 'reluctant

acceptance' framing – allowing people to express their doubts for nuclear power alongside their conditional support – concerns about climate change and energy security became positive predictors of support for nuclear power.

- Military use of nuclear power is conceived as a risk in the literature (Keller, Visschers & Siegrist 2012), mainly because it is understood that nuclear power development entails some degree of nuclear weapon proliferation risks (stemming from uranium enrichment or reprocessing of spent fuel) (Lehtveer & Hedenus 2015).

- Territorial and NIMBY (Not In My Backyard) effects are mentioned in different studies related with nuclear waste disposal (Kraft and Clary, 1991; Keller, Visschers & Siegrist 2012), siting decisions being one of the main mentioned problems for the nuclear development in many countries (Cotton, 2017).

As we will see later, our data analysis has allowed a more nuanced view of different benefits and risks related to nuclear developments in the selected countries, adding more complexity into the analysis and results.

b) Social trust

According to the literature, increased trust in the nuclear governance institutions reduces perceived risk of nuclear power, and higher trust and lower risk perceptions would predict positive attitudes toward nuclear power (Whitfield, Rosa, Dan & Dietz 2009). It is assumed that social trust can significantly influence local acceptance (Visschers, Keller & Siegrist 2011; Guo & Ren (2017), and the degree of trust earned by the several actors involved in nuclear processes is an important underlying key factor. For instance, it is said that trust in inspection authorities (Kim, Kim & Kim 2014) is crucial for the decision between opposition and reluctant acceptance, whilst trust and honesty of industry and scientists, and their "competence" (confidence), are key factors in nuclear acceptance (Siegrist, Cvetkovich & Roth 2000). The credibility and status of non-governmental organizations (Lehtonen 2010) has also been taken into account and proved to be a key factor.

An important part of the studies about social trust in risk issues are based on the 'salient values similarity theory', assuming that people who perceive that they share similar views with an actor (i.e. the managing agency) tend to trust this actor more than those who do not (Siegrist et al. 2000; Cvetkovich and Winter 2003; Poortinga and Pidgeon 2003; Walls et al. 2004).

A factor strongly related to social trust is 'fairness'. On the one hand, some scholars have shown that while individuals' self-interest appeared to be a key underlying factor in cases of acceptance (Miller, 1998), believing that decision makers are fair is also important at the interpersonal level (Besley 2010).On the other hand, some scholars distinguish between outcome fairness and procedural fairness impacts, both being important, in some cases more the first ones and in others the second ones, in increasing decision acceptance (Visschers & Siegrist 2012). In general, procedural fairness in nuclear decision processes may be a key variable in the sense that those people who believe a procedure is fair are willing to accept a decision (Besley 2010). Some studies suggest that the influence of procedural fairness is even stronger for persons who hold high moral convictions (Siegrist, Cvetkovich & Roth 2000).

Hocke and Renn (2009) found that the inability of the parties to link the technical, political, and procedural issues into an integrated approach explained part of the public opposition to nuclear decisions (i.e. waste siting). These scholars warn that neglecting of democratic procedures and public involvement may be also an important factor related with public opposition.

Finally, it is worth pointing out that frequently the development and siting of nuclear power appears to be linked to an unjustified distribution of risks and benefits (Löfquist 2015), which relates to lack of social trust in institutions and companies involved in nuclear developments.

The literature refers also to trust in information sources, and it seems clear that the associations between trust and perceived risk and benefits of nuclear power varied according to the type of information source (i.e. when talking about the role of nuclear power in mitigating climate change) (Vainio, Paloniemi & Varho 2017). These scholars showed that trust in different information sources was also influenced by political party support and other ideological background variables.

c) Psychosocial, moral and political factors

There is a growing consensus on the idea that taking into account broader socio-cultural factors whilst maintaining the necessary emphasis on safety, technological development, economics and environmental sustainability, is needed (Goodfellow, Williams & Azapagic 2011). Therefore, public perception on nuclear power is also related to more general beliefs and values which conform personal ideological systems, such as emphasis on economic versus social priorities, attitudes to technology and environmental concerns (Van der Pligt, Eiser & Spears, 1984), the social meaning of economic growth, or beliefs about the centralization of decision making (Van der Pligt, Eiser & Spears, 1984).

In general, it is known that individuals express greater or lower support for nuclear power, depending on their adherence to certain social values (such as traditional, altruistic, etc.) (Whitfield, Rosa, Dan & Dietz 2009), and that people are more likely to protest in favor of or against nuclear energy when personal norms are strong (De Groot & Steg 2010). Besides, concern about the local community is also an important determinant, a fact that may be related to nuclear power issues being conceived as general, rather than personal, matters (Sjöberg & Drottz-Sjöberg 2001). People who expressed greater concern about climate change and energy security and exhibited higher environmental values were less likely to favour nuclear power (Corner, Venables, Spence, Poortinga, Demski & Pidgeon 2011).

The Fukushima nuclear accident was followed by a significant amount of research on public perception of nuclear issues. Most of this work showed that changes in public views following the accident were moderated by political ideology (i.e. environmental views) over time (Besley & Oh 2014, Poumadère 2014, 2016). Preconceived notions about nuclear energy influenced support for the promotion of nuclear energy (Stoutenborough, Sturgess & Vedlitz 2013). It has been suggested that change in acceptance since Fukushima could mainly be explained by prior support for nuclear power (Visschers & Wallquist 2013; Siegrist & Visschers 2013), in the sense that prior acceptance levels seem to have a central role in people's acceptance of the technology after a nuclear accident.

Emotional identification can significantly influence local acceptance (Guo & Ren 2017). Affective feelings about nuclear power appeared to be a key factor (Visschers, Keller & Siegrist 2011), and those people who were opposed to nuclear power plants mainly associated nuclear power plants with negative feelings (Keller, Visschers & Siegrist 2012).

Political games are also relevant in explaining people's attitudes and behaviours. For instance, very frequently nuclear power and radioactive waste mangement issues are used by proponents and opponents as a strategic battleground to promote their respective perspectives, leading to a great social and political polarization (Hocke & Renn 2009).

It therefore seems difficult to detach the issue of nuclear energy from questions about the kind of society in which people want to live (Van der Pligt, Eiser & Spears 1984, Poumadère 2014). In this sense, Löfquist (2015) argues that closing down nuclear power plants cannot be done without large disturbances in ordinary people's lives, and therefore where this is deemed socially desirable, a reduction of energy consumption should take progressively place.

2.2. Engagement

Understanding public perceptions is an important step in attempts to engage with citizens about nuclear energy. There is no single successful risk communication/engagement process, although a number of rules and best practices have emerged such as those proposed by Covello and Sandman (2001), systematically recognizing the need to understand public perception and trust-related issues (Slovic, 2000; Siegrist et al, 2000; Sjöberg, 2001). Here we have added the sociocultural framework in which people's values and beliefs are rooted.

Empirical research has further illustrated the insufficiency of purely technocratic approaches to risk communication (e.g. Horlick-Jones and De Marchi, 1995), and two-way engagement (including actively seeking the public involvement in decision-making) has become increasingly institutionalised in contemporary technology governance.

As stated in D4.2, based on the flow of information between participants and promoters, i.e. those who have commissioned the engagement initiative, we differentiate between three engagement types (Rowe and Frewer 2005).

- *Public communication* refers to a process where information is transferred from the sponsor of an initiative to the public. There is no involvement of the public *per se*, i.e. public feedback is not required or sought.
- *Public consultation* refers to a process of conveying information from members of the public to the sponsors of the initiative, following a process initiated by the sponsor. In this process, there is no formal dialogue between individual members of the public and the sponsors.
- *Public participation* means the existence of knowledge exchange between members of the public and the sponsors. The most significant feature of a participatory engagement is that there is some degree of dialogue in the process. The flow of information is two-way, with the exchange of information opening up the possibility of perception change in both the sponsors and the public.

These three categories have proven to be effective in capturing and classifying nuclear-related engagement activities initiated by state authorities or industrial organisations. However, it turned out that beyond such 'official engagement' in the history of nuclear-society interactions the public and/or its representatives have often created and conducted their own participation activities. We suggest designating engagement actions directed from the public to regulators or nuclear companies as *'public-forced communication'* or, better, *'public initiated engagement'*.

2.2.1. Nuclear communication and engagement

In the area of nuclear developments a large amount of research about public perception can be found. Research on nuclear public engagement seems to be less frequent, although during recent years an increasing literature on nuclear waste repositories siting includes engagement-focussed analysis. Since the 80's, public involvement in techno-science largely focused on information provision, public relations, and public education. This led to 'deficit model' thinking, treating opposition towards nuclear technologies as something typical of misinformed people in need of the right data, whereby giving the correct information to the public was seen as the means to ameliorate public opposition to scientific and technological developments (Gregory and Miller, 1998; Horlick-Jones, 2009; Kurath and Gisler, 2009).

During the history of nuclear development the 'deficit model' seemed to be the hegemonic approach, and Palmer & Schibeci (2014) show that deficit models (based on one-way information dissemination) still prevail within nuclear communication, although there is some evidence of movement towards more deliberative and participatory models. Kasperson (2014) concludes also that the design and implementation of risk communication practice seems little changed over recent decades. Simis, Madden, Cacciatore & Yeo (2016) suggest that the persistence of the deficit model may be a product of current institutional structures, and it could be related to the way in which scientists conceptualize 'the public' (according to the belief that public audiences would process information in a rational manner, as they themselves were trained).

Kasperson (2014) calls for more pluralistic and deliberative modes of communication that are now required to respond to declining societal trust and ongoing difficulties in communicating uncertainty (i.e. cases in which it is difficult to calculate damage probabilities due to lack of data or due to different dimensions of damage such as technical, social, economic, etc.). This scholar argues for risk communication to be (a) more ambitious and sustained over time; (b) broadened to encompass values and lifestyles in risk issues; (c) more aware of which uncertainties matter in risk terms and which can be reduced; and (d) cognisant of the effect of limited trust on the nature of communication.

2.2.2. The key role of trust

Trust plays a key role when designing communicative processes. A substantial part of the literature shows that when people trust the promoter and regulator institutions of nuclear developments, communicative and consultative strategies tend to work quite well. For instance, Lidskog & Sundqvist (2004) described the historical development of nuclear waste management in Sweden, showing that it has been carried out with explicit reference to scientific findings, and instead it is better understood as an active adaptation to demands from different stakeholders (in the sense that sometimes the social and political context has a greater weight than the scientific findings in shaping the public acceptation).This adaptation, however, has basically been of a strategic kind, aiming to pilot an already formulated policy rather than open it up for negotiations and substantial changes. According to Lidskog & Sundqvist (2004), the waste manager (SKB) is able to interact directly, face-to-face, with the local population and establish a specific framing of the issue, gaining knowledge on what matters to local stakeholders, and being able to develop a communication strategy sensitive to local issues at the same time as its discursive understanding of the issue is disseminated.

Several studies demonstrate also that one-way information seems only to work when trust already exists (as shown in the analysis of the British nuclear waste management program made by Lidskog & Sundqvist, 2004). When there is a lack of trust, researchers claim that this could be created through opening up risk assessments and management processes to wider public involvement and greater public scrutiny (Irwin, 1995; Poumadère, 2014; Renn et al., 1995). In this way, it is argued that decisions would better reflect social values, thereby building rather than eroding public confidence.

Mah & Hills (2014) studied policy making processes and outcomes (with particular reference to the 2007 UK nuclear consultation exercise), and they found that the government approach paid insufficient attention to ‘trust’ and some other normative ‘values’ underpinning participatory governance, contributing to undesirable outcomes relating to policy legitimacy and public distrust. They suggest the significance of paying more attention to the interaction that can occur between

different rationales for participation. In the same vein, Kinsella, Andreas & Endres (2015) explained how nuclear power involves a complex discursive terrain encompassing competing promotional and oppositional narratives; ambiguous relationships to different problems (such as climate change or energy security); varied forms of negotiation and rhetorical boundary work; fragmented and often-incommensurable discourses and forms of knowledge (Kinsella et al. 2013); and organizational, institutional, and political challenges related to managing and governing a presumed high-risk technology. The concept of 'rethorical boundary work refers to the social construction of boundaries between differents spheres (economic, political, technical, etc.). As Kinsella (2013) argues, insufficient resonance between scientific, economic, and political communication systems can produce situations where system rationality increasingly loses its claim to be world rationality. Thus the rhetorical production and reification of boundaries separating these domains can, itself, be a source of risk.

In every case, the main actors involved in nuclear processes (promoters, regulators and public authorities, and affected people or receptors) interact and try to dominate the discourse based on the ability to influence the decision-making process and to mobilize public support (Jaeger et al. 2001; Renn 2008; Hocke & Renn, 2009).

A two-way relationship between communication and trust is argued. Good communication needs good trust as a prerequisite. But wrong communication can erode or promote the loss of (pre-existing) trust. In this sense, Fahlquist & Roeser (2015) argue that communication about nuclear risks is a complex territory, especially after the Fukushima event, requiring not only considerations about effectiveness, but also about ethical legitimacy. They stated that problematic effects of poor communication can be a lack of trust or a sense of hopelessness and passivity.

2.2.3. The difficult path towards participatory management in nuclear issues

In fact, during the last two decades there has been an international trend towards public participation, under the assumption that this could become the mechanism through which nuclear

decisions could be made socially robust (Flueler and Sholtz, 2004). This confirms that a top-down approach, including one-way communication, is not productive when there is a lack of trust, and that what is needed in these cases is a strategy characterized by dialogue, discussion and deliberation, where social learning – that all participants have to learn about each other's ways of perceiving and evaluating risks – have a central role.

In this sense, public participation has been recognized as a means to cope with local opposition towards nuclear projects (especially in disposal siting processes). Advocates promoting extensive public participation suggest various, mostly distinct, involvement techniques that are claimed to cover all needs. For instance, Krütli, Stauffacher, Flüeler & Scholz (2010) distinguished four discrete levels of public participation, namely information, consultation, collaboration, and empowerment, each one fitting the corresponding technical and non-technical requirements of the different phases of the process.

But the apparent consensus about the importance of participation in building social trust is not so easy to put in practice. It seems to be more a discursive wish than a true practice. For instance, Short & Rosa (2004), using the example of the failure to site a high-level nuclear waste (HLW) repository in the USA, stated that although widely regarded as a necessary condition for success, the principles underpinning stakeholder involvement are often violated in practice. They refer to key principles such as actors' representativeness, the recognition of the inevitability of uncertainty and agreed-upon ways of dealing with it; the development of 'communities of fate' and of trust among all stakeholders; the building on common values related to the environment and to the well-being of future generations; or the adherence to the rule of law (Short & Rosa, 2004).

Another deficit detected among real participative practices is that most of the bodies doing it are engaging with professional communities, more than with the broader social community (Palmer & Schibeci 2014).

Other scholars (such as Sundqvist & Elam 2010) warned about the fact that the introduction of participatory approaches (the so-called 'participatory-deliberative turn') in the nuclear sector have been focusing too strongly on procedural matters while deflecting attention away from the possibilities of using participation as a more genuine means of enabling public issues and

concerns to reach a more complex level of structuration. According to this point of view, public engagement tends to be treated as a good in itself instead of a means to favour the discussion together with the public and stakeholders, avoiding public concerns to be merely seen as troubles.

2.3. An analytical framework based on the social dimensions of risk and their relation with engagement mechanisms

Coming back to the technical concept of risk (Renn, 1992), this refers to a situation where something negative can happen, a hypothetical future possibility that can be scientifically defined by calculating the 'probabilities' and by estimating the magnitude of the potential 'consequences' (understood as harm or losses, or its reverse, benefits). From a technical perspective, risk is a combination of probabilities (from low to high) and consequences (from low to high), during a period of time. Diagrams combining probabilities and consequences are well known among risk analysts (i.e. Curtis & Carey 2012; and Cox 2008 for limitations) as a tool in guiding risk assessment in real-settings.

The 'probabilities' can be calculated taking into account historical data about failures, incidents and accidents. When these data are not available we will face some degree of 'uncertainty'. High levels of uncertainty could make difficult the decision-making about the technology in question. Different groups (companies, social movements, lobbies, etc.) can argue 'uncertainty' in order to discuss the acceptability of a certain technology, infrastructure or activity.

The 'consequences' of a technology can range from trivial impacts to serious or high severity of losses or harms, and can also be estimated according to historical data of failures, incidents and accidents. Usually, science can provide these data, but sometimes consequences are (still) unknown or hypotheses about potential losses are not fully tested yet (sometimes causal connections between risk factors and harms cannot be established because evidences are weak). Decision-making about the technology, infrastructure or activity becomes more complex, as several actors claim legitimacy to ask for their vision to be included in the process.

We would like to note that disparities between different actors' visions are also grounded on the existence of different perceptions regarding the type of 'consequences' at stake. This is a key point in our analysis. According to the above social science literature overview, several dimensions of risk can be identified.

In D4.2, we identified eight categories for evaluating public perceptions of nuclear energy: trust, national economics, consumer economics, local impact, environmental impact, social & ethical impact, health impact, and risk of catastrophic accident. Furthermore, we analysed public perceptions from just one actor category: the 'receptors' (or affected people). In order to include also the perceptions from other categories of involved actors in nuclear interaction contexts (such as the 'promoters' and the 'regulators'), we have further developed our framework and re-classified our conceptual categories into four general dimensions: health & environment, economics, socio-cultural, and political-institutional. These general dimensions can be defined as follows:

- *Health & Environment dimension:* This dimension includes the perception of positive and/or negative effects related to human health (acute or chronic effects) and to environmental issues (water, soil and atmosphere pollution, loss of biodiversity, climate change effects, etc.), and also safety concerns and other control-management related factors. Former categories derived from D4.2 include 'health impact', 'environmental impact' and 'risk of catastrophic accident', which here represent different sub-dimensions (among others).

- *Economic dimension*: This dimension refers to the perception of factors related to economic issues, in positive and/or negative ways. It encompasses topics such as potential (or actual) job creation, new business related to the construction or management of nuclear infrastructures, potential economic losses due to nuclear incidents, security of supply, industrial progress, resource requirements, concerns about energy prices, etc. Former D4.2 categories included (partially) in this dimension are 'local impact', 'national economics' and 'consumer economics'.

- *Socio-cultural dimension*: This dimension refers to several factors identified in two different theoretical approaches - namely the psychometric paradigm and the cultural theory of risk. The basis for the first approach is evidence that, as opposed to what might be expected, there is not always a linear relationship between the perception of benefits generated by an activity or technology and the perception of the risks it involves (contributions of psychometric approach and cultural theory would support this dimension). The D4.2 categories 'local impacts' and (partially) 'social & ethical impacts' are included in this new general socio-cultural dimension, along with other aspects, such as local social networks, territorial identities, locally unwanted land uses, life styles, cultural traditions, values, beliefs, world-views, etc.

- *Political-institutional dimension*: In order to understand people's responses to a risk, it is not enough just to know about their perceptions. There is also the need to analyse the context of the social relations in which these responses take place, taking into consideration pertinent institutional dimensions like credibility, trust, perception of injustice or inequality, governance issues (etc.) (Wynne, 1996; Renn, 2008). From this perspective, there is a need to consider that when people evaluate a potential hazard, they implicitly make an evaluation of the institutions that promote and manage it, and generate a judgement about the credibility or trustworthiness that these deserve. Categories such as 'trust' (already identified in D4.2), but also credibility, perception of injustice, equity, confidence in institutions, governance issues, etc. are part of this general dimension.

These conceptual assumptions, i.e. our integrated theoretical framework, allow us to better distinguish the structure of the perceptions of the actors related to nuclear energy. In this way, we not only distinguish between proponents or opponents of nuclear energy, but also are able to identify the specific dimensions that underlie actors' support or rejection of nuclear technologies. This will allow us to better explain the frequent ambivalences related to nuclear developments, such as when (for example) an actor agrees that nuclear energy constitutes an economic benefit while at the same time considers it unacceptable because it imposes threats to certain local identities, is linked to undesired uses of the territory, or because of a lack of trust in the managing

institutions. This analytical approach could be very useful to better understand actors' perceptions, and therefore to better understand the engagement activities in which they are involved.

The relationships between the four analytical dimensions are not linear. Following the literature review (Whitfield, Rosa, Dan & Dietz 2009; Visschers & Siegrist 2013; Huang, Zhou, Han, Hammitt, Bi & Liu 2013; Tsujikawa, N., Tsuchida, S., & Shiotani, T. 2016), we are proposing a particular mode of interaction between the dimensions of risk (figure 2), inspired by the main assumptions identified in the literature review.

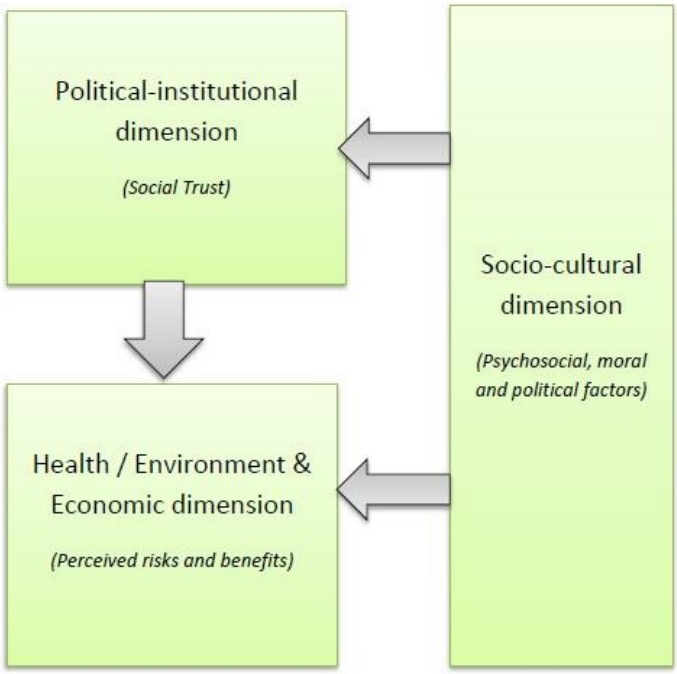

Figure 2: Relationships between the dimensions of risk (Source: authors)

We argue that this model has impacts in the engagement strategies to be implemented in every case-study. In each case, the first task will be to identify the arguments used by each actor to justify it's proposal, strategy, or opinion. Based on this, we can find several situations, and in each

one the relationship between perception and engagement will be different while at the same time being shaped by the following three general principles:

It is obvious that if the dispute relies on concerns about safety, health or environment, or on economic issues, data to achieve agreements, to deny arguments, or to convince the contrary could be found and discussed.

But if the dispute focuses on the people's lack of trust or confidence in the institutions in charge of managing nuclear issues, things become more complex. Although many objective data could be provided, it will still be difficult to achieve an agreement. In these cases, what is under discussion are not objective data, but rather the capacity of institutions or companies to be trustworthy. Trustworthiness is not only composed by technical values (expertise), but also by a subjective dominant dimension (fairness) which is very difficult to manage (especially when it has been lost).

Finally, if the arguments in controversies revolve around questions of social identities, values and beliefs, etc., then the communication of objective data will also probably be unfruitful (although it has to be done anyway) since what the actors are looking for is some kind of recognition on the part of others (claiming status, dignity, etc.). The difference with what is said in the previous paragraph is that, while there the reason for the dispute lies in the relationship between people and institutions (trust relations), in this last situation the conflict is based on community social relations, which give rise to to ideological positions, social identities, etc. Our case-studies will be based on this framework analysis.

2.4. Methodology and sample

The social science methodolgy has been conditioned by the specifications of the original EU call (NFRP-12-2014), which mandatorily established a project in three phases:

In the first phase, historians shall provide the core facts and figures, based on available documents and other sources of information, complemented as appropriate by field investigations, notably interviews of major players with regard to the selected developments and projects. This should result in a well-organised and documented database and historical record (the SCRs).

The second phase shall bring-in social science specialists in order to analyse and interpret this information from the perspective of furthering the understanding of the mechanisms for effective interaction with civil society regarding nuclear applications and projects, including the factors underlying perception, participation and engagement.

In the third and last phase, the results shall be presented and discussed with industry, associations, policy makers and representatives of the civil society.

According to these very detailed specifications of the EU call, the possibility of social scientists obtaining information on their own was not contemplated, in principle. However, although these were the specifications of the call, in the HoNESt project we have tried to go further and implement a more integrative approach, by embedding the research process in an interdisciplinary framework combining historical accounts of nuclear developments with social science analyses of public perceptions and stakeholder engagement. To achieve this, we developed a methodology that enables social scientists to analyse the data and reports delivered by HoNESt historians – given the differences in disciplinary norms within their respective fields. In the first place, contents of the SCR will be compiled on the basis of historian's research methods, and be framed by a chapter structure commonly decided upon by historians and social scientists in WP3. To further underline the interdisciplinary character of HoNESt, members of both disciplines developed a set of guiding questions historians should aim to take into account when compiling their country studies. In this sense, within WP3, a Guidance Framework (GF; cf. D3.1) has been designed to support historians in data collection and generating short country reports.

Historians will use the GF as a compass for gathering, prioritising, and consolidating the data they found in sources such as archives, documents, etc.

We aim to identify and analyse the public perceptions and communication and engagement activities carried out by the different actors involved in nuclear developments. In order to enable clear distinctions between different originators and receptors of engagement processes, HoNESt researchers have developed the following scheme consisting of four actor types.

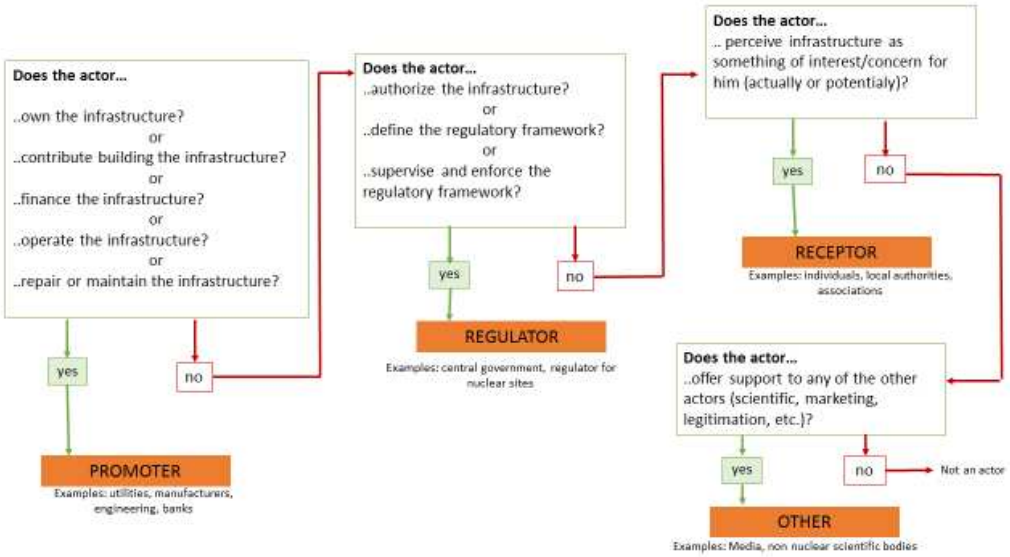

Figure 3: Actor's taxonomy (Source: Rubio-Varas et al., 2016)

For the purpose of D4.3, we feel it useful to introduce a slighty changed terminology regarding the actor category 'Regulator'. Because not all actors involved in regulation activities may actually be 'Regulators', we instead decided to talk of 'Public Authorities' referring to Regulators and others in charge of making regulations.We are aware that in nuclear decision processes 'Public authorities' may belong to several actor types, especially in siting processes, where local and regional governments can be classified as 'Receptors'. It is the specific context of each case which determines whether a public authority behaves as a regulator or receptor.

A synthesis of the findings of the analysis of 'key events' and the 'historical narrative'[1] of each selected country has been done in the following way:

1. Filling in an analytical grid (composed of the analytical dimensions proposed above) for every key event, and for the country narrative.
2. Interpreting the results by trying to understand the underlying patterns in the use of arguments and discourses related to the general analytical dimensions characterized above:
    - Health & Environment dimension
    - Economic dimension
    - Socio-cultural dimension
    - Political-institutional dimension

As the events and narratives are the sources of the perception and engagement analyses, table 2 presents a list summarizing all events.

Table 2: List of analysed events

Bulgaria	General narrative
	Event 1 - Starting the experimental reactor IRT-2000 near Sofia in 1962
	Event 2 - Starting the NPP Kozloduy and the Vrancea earthquake – 1974-1977
	Event 3 - Reaction of the Green movement to the Chernobyl accident
	Event 4 - Initial negotiations and contract with the European Union for memberships, which included decommissioning reactor 1,2,3,4 at Kozloduy NPP – 1993- 2004
	Event 5 - Referendum for constructing new atomic power plant in Bulgaria- 2013
F.R. Germany	General narrative
	Showcase - Wunderland Kalkar
	Event 1 - German Atomic Program – First Nuclear Research Centre
	Event 2 - Civil Society Interaction—The Wyhl Example
	Event 3 - Civil Society Interaction—The Wackersdorf Example
	Event 4 - Civil Society Interaction—The Gorleben Example
	Event 5 - Energy transition after Fukushima
Finland	General Narrative

[1] All short country reports produced by HoNESt historians follow the same structure. Beyond a 'Showcase' and a 'Facts and Figures" section they provide about five 'Events' crucial for the country's nuclear history, a 'Showcase' with a more in-depth depection, and a comprehensive overview of its 'Historical context (narrative)'. Some reports added one or more appendix describing key themes or current issues (as the USA case). This deliverable is based on the descriptions and analyses of the reports' "events" and "narrative" sections.

	Showcase - Collective memory and the uneasy nuclear collaboration between Finland and Russia/Soviet Union
	Event 1 - From isolation into transnational networks
	Event 2 - Finnish nuclear power project 1955-1962
	Event 3 - Transnational organizations and the Cold War politics
	Event 4 - Surprise in Moscow
	Event 5 - Becoming the "Atom town"
	Event 6 - First nuclear debates
Spain	General Narrative
	Showcase – Valdecaballeros NPP (built but never operative reactor)
	Event 1 – Vandellós I (nuclear incident in 1989)
	Event 2 – Ascó Nuclear Power Plant
	Event 3 – Basque antinuclear movement
	Event 4 – Nuclear moratorium 1983
	Event 5 – Nuclear Repository Waste (sitting process)
Sweden	General Narrative
	Event 1 - The atomic weapons controversy
	Event 2 - TMI and the referendum on nuclear power
	Event 3 - Local protests against a repository
	Event 4 - Chernobyl and its effects in Sweden
	Event 5 - A competition for getting a repository
UK	General Narrative
	Event 1 - First nuclear weapons test 1952
	Event 2 - First nuclear power station opens 1956
	Event 3 - Windscale Fire 1957
	Event 4 - SGHWR chosen as AGR replacement 1974
	Event 5 - Royal Commission on Environmental Pollution 1976
	Event 6 - Sizewell B public inquiry 1982-5
	Event 7 - Government repositioning on new build NPPs 2006
Ukraine	General Narrative
	Showcase – Dealing with Chernobyl disaster aftermath
	Event 1 - Chernobyl disaster (April 26, 1986)
	Event 2 - Post-Chernobyl anti-nuclear protests and vote on the moratorium on the construction of new nuclear reactors (1989-1991)
	Event 3 - Vote on the repeal of the moratorium and relatively weak anti-nuclear protests (1993-1994)
	Event 4 - Controversial negotiations on the closure of the Chernobyl NPP and public hearings on the completion of the Kmelnitsky 2-Rivne 4 nuclear reactors in exchange (1994-2000)
	Event 5 - Start-up of the Kmelnytska 2-Rivne 4 nuclear reactors (2004) as part of strategy aiming at "nuclear revival" and new public information effort
USA	General narrative
	Showcase - Early Demonstration Projects

	Event 1 - Licensing and Operation of Enrico Fermi (Detroit) Breeder Reactor
	Event 2 - Licensing and Protest over Diablo Canyon NPP and the Abalone Alliance Protests
	Event 3 - Three Mile Island, Pennsylvania, 1979
	Event 4 - Seabrook Nuclear Power Station and Clamshell Alliance Protests
	Event 5 - Davis-Besse NPP Operation and Reactor Head Corrosion (2002)
	Appendix 1 - Current Status and Plans: Nuclear power in the US
	Appendix 3 - Reactor Safety Studies
	Appendix 4 - Radioactive Waste and Spent Nuclear Fuel

Source: own depiction

The conditions in which nuclear energy has been developed in different countries vary greatly over time, since each historical phase is characterized by a specific political, social and economic context. Therefore, for the analysis of all the data available in the SCRs, it has been decided to distinguish three main historical phases:[2]

- Phase 1: 1950 – 1970: Post-war developments and Atoms for Peace. First phase of nuclear energy development.
- Phase 2: 1970 – 1990: Economic growth and public mobilisation. Three Mile Island (TMI) and Chernobyl accidents impacted the public opinion.
- Phase 3: 1990 – 2015: Drop of the Iron Curtain. Globalization. Climate change, peak-oil, energy crises and the role of renewables. Fukushima accident.

The following section shows the results (key findings) on public perceptions and engagement initiatives identified in the selected case studies, according to how they were described by the Historians team in the Short Country Reports (SCR).

[2] These three phases were discussed and defined by the HoNESt Consortium at the Barcelona meeting (2016, October the 6-7th)

3. Public perception and engagement in the selected case studies

Based on the texts (SCR) written by the team of Historians for each selected country, this section explains how each of the dimensions of analysis is discussed, highlighting its content in different historical periods. Concrete verbatim excerpts on which the explanations are summarized and the synthesis tables can be found in Annex 1 and 2 respectively.

3.1. Perception of risks and benefits of nuclear power: Key findings

According to our proposed analytical framework, the risks and benefits can be interpreted as those factors belonging to the health and environment and economic dimensions (see figure 2, above).

The analysis carried out shows that the perceived risks are very similar in all the countries sampled. The most frequently mentioned risks (see table 3) are those related to the possibility of accidents and radiation contamination; in both cases these include damages or losses that may affect human health or the environment (especially aquatic, fluvial or marine environments). There are also concerns about the safety of nuclear facilities, as well as episodes of stress and anxiety in some people when confronted by the possibility of such risks materializing.

It can be said that a large part of the references to health concerns related to nuclear power were reported in the period 1970-1990, although some fewer references can also be found in other periods. This tends to coincide with the period of higher social mobilization against nuclear projects around the world. This means that most of the protests used to be based on health and environmental arguments, although there could be other dimensions involved that were not obvious (not explicit).

Regarding ‘actors’, mostly the ‘receptors’ (affected people) expressed concerns about health effects, but neither promoters nor public authorities (regulators, etc.) tended to focus on this dimension, and when this happened they tend to express the low probability of these potential

harms (as such in the USA case, event 3, see annex I)[3] or highlighting its potential healthy uses (as such in the Finnish case, event 1, see annex I).

In similar terms, although roughly absent during the first period of the nuclear development, since the 70's the environmental risks became a dominant argument among all the involved 'actors'. Since then, perceptions of positive and/or negative effects related to environmental issues, such as water, soil and air pollution, and climate change impacts are reported in the SCRs (see the annex I). Affected people (receptors) highlighted in a broad sense the potential environmental impacts of nuclear facilities (actual in the cases like Chernobyl in Ukraine). On the contrary, we identified only a few references to these impacts on the promoters and regulators side, usually hinting at positive impacts such as mitigating climate change. We are aware that this could be seen as a kind of truism as the scientific community has stated that, despite the low probability of accidents with large radioactive releases, a technology requiring evacuation plans should not be further promoted. In fact, promoters tend to say that generation IV technology would aim at inherently safer systems, therefore avoiding the need of evacuation plans.

Regarding local receptors, the SCRs show several cases of municipalities arguing about potential environmental dangers if hosting a repository (i.e. Sweden, event 3, see annex I), and some social movements opposed to it and advocate for other technological options (less risky). However, in some countries (i.e. UK, event 7, see annex I), receptors seemed to agree with a 'reluctant acceptance' of nuclear power because it could help in coping with the low-carbon energy and climate change challenges.

The perception of risks related to the high economic costs that nuclear projects entail is also relevant, as is the concern related to the supposedly low sustainability of nuclear projects (in environmental, economic or social terms).

[3] From here onwards we are putting the concrete references of the cited arguments indicating to which section or event of the respective SCR they belong,. For instance, in this case we are refering to the event 3 of the USA report, to be found in Annex I. All the concrete selected fragments to illustrate our argumentation can be found in the Annex I, classified by theme, historial period and country. The SCRs correspond to the February 2017 versions of the SCRs available in the project webpage (http://www.honest2020.eu/), most of which are under revision when writting this report. When we have the definitive final versions these references will have to be updated.

Interestingly, there are hardly any differences by country. The same concerns (the same perceived risks) appear more or less clearly in all the studied countries.

However, there are some differences in relation to each historical period. While in the first period (1950-1970) the mention of risks is low, during the second period (1970-1990) the references to risks multiply, and in the third period (1990-2015), there is less mention of them in the SCRs (although always more than during the first period). However, we should approach these data with caution since our analysis is not based on a quantitative approach, but on a qualitative one, and for that reason quantities or frequencies are not relevant in this context. The focus of our analysis is placed on arguments, themes, actors and historical phases.

Table 3: Perceived risks of nuclear energy identified in the selected case-studies SCRs, by periods.

1950-1970	1970-1990	1990-2015
F pollution	B Health and safety	B technical safety
F safety culture	B emergency	B safety conditions
G high cost	B stress, anxieties	F accident
SP high cost	B safety	F non-carbon-free
SW safety	B high cost	F Low sustainablility (2)
UK radiation	G safety	F high costs (3)
U financial damage	G pessimistic view	SP High costs
US Accident	G high costs (2)	UK High costs
US high cost	SP radiation (2)	UK environmental concerns
	SP safety	U High costs
	SP High costs (3)	U safety
	SP economic uncertainties	US environmental impacts
	SW Accidents, fears and anxieties	US safety
	SW environment dangers	US High costs
	SW high costs (2)	
	UK concerns about the environment	
	U radiation (2)	
	U damage for health (2)	
	U Environmental concerns	
	U economic compensations (2)	
	US accidents	

	US safety US high costs (2)	

Source: own depiction based in the in-depth analysis of the SCR. Each line means that this risk is mentioned in the respective SCR, (numbers in brackets when it appears more than once) (Code: B = Bulgaria; F = Finland; G = F.R.Germany; SP = Spain; SW = Sweden; UK = United Kingdom; U = Ukraine; US = United States).

What about the perceived benefits? Although they are less mentioned than the risks, the SCR also mentions the benefits perceived in the promotion of nuclear energy.

In the same way as the perceived risks, the perceived benefits are relatively similar among all the countries in the sample (table 4). In all the countries there are actors who argue that nuclear energy will bring benefits of different types, especially in economic terms (jobs, socioeconomic development, inexpensive electricity or a guarantee of energy supply), but also (to a lesser extent) environmental benefits, and even for human health.

Environmental impacts were used in different ways along the different historical phases. References to positive environmental effects of nuclear energy appeared already in the first period as a response (from promoters and public authorities) to the early concerns of the public, whom at this time was not much worried about it (i.e., Finland, Event 5, see annex I). During the second period (1970-1990), after recognizing its potential negative impacts, promoters and public authorities tried to explain its relative importance and, in some cases, to highlight its potential positive environmental impacts (i.e. Sweden, General narrative; Spain, Showcase; see annex I). These arguments increased since the 90's, when promoters and public authorities argued that without nuclear power stations the international climate agreement cannot be fulfilled (is the case of Finland, General narrative and Showcase; UK, General narrative and event 7; or USA, General narrative and event 1; see all the concrete excerpts in annex I). According to this interpretation, nuclear power would play the role of a preventative measure in mitigating environmental risks.

Another argument mentioned is that some people (mainly promoters/regulators) have a high degree of confidence in the technical safety of the nuclear industry (which could be interpreted as a benefit or positive impact). (i. e. the cases of Finland, General Narrative; Spain, Showcase and event 2; UK, General narrative, event 4 and event 5; see annex I).

Unlike the perceived risks, which remain more or less stable throughout the three contemplated historical phases, regarding benefits, some small changes are observed through time, specifically with respect to environmental benefits. In the first two phases (1950-1970 and 1970-1990), some actors talk about positive environmental impacts of nuclear energy production,such as temperature increases that could favor certain ecosystems, economic activities, and less pollution than other industries (i.e. Sweden, General narrative; Spain, Showcase, see annex I). However, since 1990 there are no more references of this type, and instead, they speak more about the benefits of nuclear energy in the fight against climate change. Additionally, it is worth noting that there are hardly any differences between the perceived benefits in the different selected countries.

Table 4: Perceived benefits of nuclear energy identified in the selected case-studies SCRs, by periods.

1950-1970	1970-1990	1990-2015
F energy supply	F safest	F climate change challenges
F inexpensive electricity	F useful for medical healthy uses	F jobs
F jobs	G clean and safe energy	F radiation is a natural phenomenon
F jobs (high quality)	SP energy supply	F safest
F socioeconomic development	SP Jobs	SP radiation is a natural phenomenon
G socioeconomic development	SP positive environmental effects	SP socioeconomic development
SW positive environmental impacts	SP Safest standards	SW Jobs
US investments (business)	SP socioeconomic development (2)	SW safest (2)
	SW inexpensive electricity	U economic viability
	SW investments (business)	U safest
	SW safest	UK climate change challenges (3)
	SW suitability	US investments (business)
	UK safest	
	US healthy	

Source: own depiction based in the in-depth analysis of the SCR. Each line means that this benefit is mentioned in the respective SCR, (numbers in brackets when it appears more than once) (Code: B = Bulgaria; F = Finland; G = F.R.Germany; SP = Spain; SW = Sweden; UK = United Kingdom; U = Ukraine; US = United States).

It is observed that perceived health and environmental issues are closely related to the perception of technological safety. Some reflections on **safety** concerns according to the analysed SCRs are needed: In general terms, most of the safety concerns regarding nuclear

energy arose after the 1970's. Before this date few doubts about safety issues were found among the SCR (only the Finnish fears about Soviet designs, and reported criticisms in Sweden from technical experts and politicians regarding safety requirements of the reactors) (Finland, Event 4; Sweden, General narrative, see annex I). However, since the 1970's, safety concerns are frequently used to define arguments for or against nuclear developments. On the one hand, contradicting attitudes came from the public and specific experts on issues concerning the safety of the reactors, while receptors showed increased concerns about the location of the nuclear installations because of safety issues (F.R. Germany, Showcase, and event 3, see annex I). After international nuclear accidents, such as TMI and Chernobyl, their claim for safety was reinforced. On the other hand, promoters and regulators tend to focus on high technological expertise and innovations to argue for the guaranteed safety of the NPPs. For example, in Finland new reactors were considered by the nuclear Promoters and Regulators far safer than those of TMI or Chernobyl (Finland SCR, General narrative; see annex I). In Spain Promoters argued that the technology was safe and effective (Spain, Showcase; see annex I). While in the UK, the public authorities made decisions based on the assumption that British citizens required confidence that their government had chosen the safest available nuclear technology (UK, General narrative, and event 4, see annex I). However, not all the public authorities were able to maintain the image of nuclear power as a safe energy source. For instance, in the F.R. Germany it was not possible after the Chernobyl case (F.R. Germany, Event 3, see annex I), nor in the USA after the Three Mile Island (TMI) accident revealed weaknesses in the regulators' and promoters' actions (USA, Event 3, see annex I), which in turn led to increased regulatory powers and a renewed safety philosophy among regulators.

Few changes have been detected since the 1990's on these arguments, neither in the Receptors' perceptions nor among the Promoters and Regulators' side. The only remarkable differences are those in Bulgaria and Sweden. In Bulgaria, Promoters and Regulators continued to express their satisfaction with the technical safety issues, in contrast with the opinion of international agencies (Bulgaria, Event 4, see annex I). In Sweden, Regulators continued arguing they had the most appropriate technology, but later changed their strategy to a more engagement oriented strategy with local municipalities who were willing to host repositories (Sweden, Event 5, see annex I).

In general, different dynamics are observed among the actors' behaviours. The promoters almost always argued for a high degree of safety measures and standards, although in the F.R. Germany case, public authorities tried to convince the promoters about nuclear power safety (in early times). The regulators and public authorities were traditionally linked to the promoters (probably because nuclear technology needs full support of the state, at least in early steps), but over time they tend to act in a more autonomous way (mainly after TMI the independence of Regulators was strengthened and they became autonomous bodies), sometimes publicly criticizing the promoters' actions. The receptors were also concerned about safety issues, with respect to both the people living in the areas near NPPs and the environmental social movements operating in the territory. Additionally, the safety measures were known and positively considered by some local governments (of the municipalities hosting the NPPs), and specific social groups (workers of the plant, etc.).

Regarding the **economic** dimension, we can detail some additional arguments found in the SCRs:

Job creation seems to play a role in the negotiations between promoters, public authorities and receptors of nuclear energy infrastructures, but this does not seem to have motivated too much attention among the drafters of the SCRs. In the first period is only mentioned in the Finnish SCR (event 5, see annex I); in the second period it appears in the Spanish SCR (Showcase, and event 2, see annex I); and in the third period it is detected in the Finnish SCR (General narrative, see annex I) and in the Sweden SCR (event 5, see annex I). Besides, it seems that promoters and public authorities managed a risk-benefit model, taking for granted that with the appropriate economic compensation the people would accept their risk exposure. However, in several cases sooner or later public rejection appeared, proving that those assumptions were erroneous, maybe as indicative of other variables involved in the explanation of people's behaviours.

It is clear that in some countries (as such as F.R. Germany, Finland, Spain, USA) nuclear energy is presented by the Regulators and Promoters as a trigger for **technological and industrial**

modernization, and as a path to becoming part of high developed countries. In some cases (F.R. Germany) a shift in this idea has been observed since the 1970's and the 1980's.

Few references have been detected in the SCRs related to the guarantee of **energy supply**, and they are predominantly in the early times (in the Finnish and in the Spanish SCRs). It seems that in the last considered period (1990 – 2015) this issue was not so relevant as the previous periods (perhaps because other sources capable of guaranteeing security have been maturing).

The impact of nuclear energy on **energy prices** is a factor taken into account in some SCRs (Finland, Sweden, UK). Its relevance seems more present in the first and second considered periods than in the third one. Different attitudes regarding this topic can be detected among different actors, confronting the wishes of maintaining cheaper tariffs with the need of moving towards more sustainable energy systems and growth. Opinions on this topic have evolved over time, apparently being more frequent in the past than in recent times.

The **high cost** of nuclear energy projects has been an argument used by many actors both to justify their reluctance in investing in these projects and cancel on-going projects, but also to justify continuing with a project once it had been initiated (in this case avoiding potentially larger economic losses from projects already invested in case they were stopped). In cases such as those of FR Germany and Bulgaria, promoters and regulators were critical of nuclear power because of the high cost associated with them (Bulgaria, event 2; F.R. Germany, Showcase, see annex I). In other cases, such as in Spain, financial facilities were crucial for the business decision-makers in order to proceed with or cancel their nuclear projects (Spain, General narrative, and event 4, see annex I). This results in the need of an active and key role of the State in promoting nuclear development in all kind of countries (both democracies or dictatorships). In some cases, such as in Sweden, although receptors decided to stop the nuclear program (through the non-binding referendum in 1980), this did not happen because economic losses were argued by the public authorities (Sweden, event 2, see annex I).

Arguments about the high costs of nuclear energy were mainly publicised by receptors and included not only the economic costs caused by the accidents, but also the costs resulting from further regulations derived from the accidents. In some ways, accidents are interpreted as a

driving factor of the **increased resources** needed to implement the nuclear sector (to cope with the efforts in design/procedures for accidents' mitigation).

3.2. Political-institutional factors: Key findings regarding social trust

In general, although the perceived risks (and perceived benefits) are very similar in all the countries studied, the social and institutional responses are very different. In some countries, public opinion is more receptive to nuclear development, while in others it is more hostile. Why? And what relationship does this fact have with the communication and engagement policies implemented in each country? In order to answer these questions, we first need to understand how people perceive their relationships with institutions (social trust, or what we have considered here as the political-institutional dimensions), as well as what kind of socio-cultural factors are part of the context in which the nuclear technology is perceived.

The analysis carried out allows for the identification of a series of factors related to political-institutional dimensions of nuclear energy, which strongly shape social trust in every country.

According to the interpretative and contextual theories of risk it is not so easy to separate perceptions of nuclear issues from their social, economic or political context of production. We should consider that when people evaluate a technology or activity, they are also implicitly making an evaluation of the institutions that promote, manage, and regulate it, along with generating a judgement about the credibility or trustworthiness that these deserve. In this sense, distrust is related to the perception that these institutions have carried out some kind of incorrect or unethical behaviour, for example by favouring private interests above the public, by acting against the law or by keeping secrets (which at some point were revealed to the public). In fact, we have found several cases where the public raised concerns about the secrecy of the information provided by promoters and/or regulators.

The main political-institutional factors identified in the SCRs are the following (table 5):

- Low institutional trustworthiness, which draws attention to the fact that the behaviours of the institutions in charge of managing or regulating nuclear energy have been perceived

as not worthy of trust by certain social sectors. In the SCR there are many examples of these type of behaviours generating mistrust.

- Political games (i.e. elections affected decision-making, political parties changed their opinion about nuclear developments when governing, disputes between pro and anti-European parties, etc.)
- Dependency on other countries conditioned decision-making, leading national governments to adopt certain behaviours in order to gain energy autonomy or to avoid dependency.

It must be said that these factors are distributed differently among the different countries, which explains the different social responses in each place. For instance, concerns about the 'dependency on other countries' appears more in the Eastern countries (Bulgaria and Ukraine), but also in Finland. Additionally, in some countries such as the UK and Finland, a higher perception of trust in institutions has been found than in the other countries; while political games appeared stronger in the German and the Spanish cases. Later we will try to classify the selected countries according to these criteria.

Table 5: Political-institutional factors shaping social trust identified in the selected case-studies SCRs, by periods.

1950-1970	1970-1990	1990-2015
B Dependency of other countries conditioned decision making F Dependency of other countries conditioned decision making SW Political games (coming elections conditioned decision making) UK Low institutional trustworthiness (due to the government's handling of an incident, and the secrecy surrounding it) US Low institutional trustworthiness (Promoters made promises not fulfilled)	B Low institutional trustworthiness (secrecy in case of Chernobyl accident) F Dependency of other countries conditioned decision making (self-sufficiency had dropped) F Political games (Opposing nuclear program due to anti-nuclear weapons treaties) G Low institutional trustworthiness (Lack of trust in government's willingness to seriously consider people's concerns) G Political games (proximity of	B Political games (discrepancies between institutions) B Political games (fighting between pro and anti-European parties) F Dependency of other countries conditioned decision making (preferences for an energy source that could guarantee a high degree of energy independence) F Perception of good commitment with public interest (high levels of trust) SP Political games (policy makers changed opinion about nuclear

US Low institutional trustworthiness (regulators captured by the industry and by military interests)	political elections conditioned making decisions) SP Low institutional trustworthiness (after illegal works, legislation was adapted to the nuclear industry interests) (2) SP Low institutional trustworthiness (Promoters did not tell the truth) SP Political games (political parties changed opinion about nuclear developments when governing) SW Low institutional trustworthiness (Promoters ignored results of a referendum) U Low institutional trustworthiness (secrecy in case of Chernobyl accident) (2) U Political games (public opinion accepted NPP once Ukraine was constituted) UK Perception of good commitment with public interest (high levels of trust in public authorities) (guaranteeing the safest technology) US Low institutional trustworthiness (Regulators did not act in favour of common public interest) US Low institutional trustworthiness (Regulators did not act in favour of common public interest) (3)	developments due to political strategies of the electoral arena) U Dependency of other countries conditioned decision making (European West-East distrust situation) U Dependency of other countries conditioned decision making (nation's economic survival lead to nuclear acceptation) UK Low institutional trustworthiness (secrecy in case of private reactor management) US Dependency of other countries conditioned decision making (energy independence aspiration) US Dependency of other countries conditioned decision making (losing energy autonomy) US Low institutional trustworthiness (Regulators did not act in favour of common public interest)

Source: own depiction based in the in-depth analysis of the SCRs. Each line means that this factor is mentioned in the respective SCR, sometimes more than once (numbers in brackets) (Code: B = Bulgaria; F = Finland; G = F.R.Germany; SP = Spain; SW = Sweden; UK = United Kingdom; U = Ukraine; US = United States).

The Bulgarian SCR explains the country's vast dependency on the Soviet Union's technology and development model (Event 1, see annex I) during the first period (1950-1970), which conditioned the public (and institutional) perception of nuclear energy. During the second period (1970-1990), the secrecy of information provided by public authorities (event 2and 3, see annex I) framed the

public perception of the government itself. This generates a situation of distrust of the government as a communicative actor. In the third period (1990-2015), the political fight between pro and anti-European parties conditioned the national nuclear agenda (Event 4). While pro-EU parties agreed with the shutdown and change of nuclear reactors, the anti-EU parties advocated keeping all of them. At political level, again the nuclear power discussion among regulators/promoters was used as an issue of how the country is positioning in the new membership for the EU (specifically, on the issue of changing technology to other reactors (whether to keep old reactor or adapt them to new technologies). Bulgarian socialists wanted to keep all of the reactors with the argument of their strength and profitability. While Bulgarian democrats and pro-EU parties and officials were willing to compromise arguing that such step would be better for the Bulgarian country. In fact, the building of a new NPP (Event 5, see annex I) reactivated the debate on energy (and political) dependency because it might help to diminish the energy imports from Romania and Turkey, while increasing dependency on Russian technology (Event 5, see annex I).

In Finland, the history of nuclear energy is linked to strategic international political relationships of the country since the first period (1950-1970). So, it is suggested that Finland became member of the United Nations organization due to its participation in nuclear projects (General narrative, see annex I). The diplomatic relationship with the Soviet Union conditioned some decisions on nuclear programs (event 1, 2 and 5: see annex I). The Finnish SCR is full of references to the debate about national energy dependence and/or self-sufficiency. The whole nuclear program is justified from the beginning and during several decades as a key factor to ensure energy independency. The particular geostrategic position of the country during the Cold War, in-between East and West, facilitated the political preferences for an energy source that could guarantee a high degree of energy independence. The energy dependence from the Soviet Union is presented as a reiterate concern. During the second period (1970-1990), the Finnish SCR continues to give high importance to this argument. So, public authorities in Finland noted the country's dependency on energy imports and that the level of self-sufficiency had dropped since the early 1960s while the demand of energy continued to grow. The conclusion was that if no new nuclear power stations were built, self-sufficiency would go progressively down. In the period 1990-2015, the Finnish SCR says that the country has a governance system including authorities, nuclear companies and government agencies deciding together in closed cabinets, but having

high levels of trust among public opinion. However, during last times some projects are accumulating troubles and nobody is able to say when the power stations were ready and how much they would eventually cost (General narrative, see annex I). Besides, in Finland there are some nuclear developments that would help to decrease energy imports (from Russia) and improve self-sufficiency, but due to unavoidable geopolitical decisions Finland becomes dependent on Russian nuclear technology. (Showcase, see annex I).

In the F.R. Germany lack of trust in government and regulators seemed to be a popular point of criticism among the groups against nuclear energy, in particular during the second period (1970-1990). The criminalization of antinuclear activists was interpreted as a source of mistrust among the receptors, leading to a lack of trust in government's willingness to seriously consider people's concerns (General narrative, and event 4; see annex I). Left-wing critics perceived this collusion between the state, the regulators and promoters in terms of left-wing ideas. Ideas of the high-security 'nuclear state' also played a role in this debate (Showcase, see annex I). Besides, in some cases, according to the German SCR, the proximity of political elections was the main factor that influenced the government to postpone the choice of the place where a NPP should be built (Event 4, see annex I).

In Spain, in the early phases of nuclear development (period 1950-1970), the industry created its own rules by manoeuvring within the dictatorship and even ignoring the law in their dealings (General narrative, see annex I). The lack of checks and balances in the dictatorship shaped the public image of the nuclear sector among the public for long time. During the second period (1970-1990), in several cases the public authorities later legalized illegal works when building NPPs (Showcase, and event 3; see annex I). The legislation was adapted to the NPP interests generating great distrust among the public (receptors) (event 2, see annex I). There were also cases where the promoters did not tell all the truth about their intentions when acquiring land for siting the NPPs (according to the press, they said they want to promote chocolate factory in Event 2, see annex I). Besides, in Spain, there are several examples of political games that created distrust among the public: sometimes a political party expressed its anti-nuclear principles but later, when governing, changed opinion and maintained or supported NPPs (Event 2, see annex I); and the opposite happened between different territorial levels, even governed by the same

political party, e.g. when the central government supported nuclear siting and the regional (autonomous) government stopped it (trying to increase its legitimacy by demonstrating sensitivity to social demands in the region) (Showcase, see annex I). During the period 1990-2015, the issue of vested interests was raised by several actors, mostly regarding supporters of a waste repository (Event 5, see annex I). The existence of contradictory external reports (about the siting features or nuclear impacts) was a source of distrust among the actors too. In Spain there are cases in which a political change in the local and regional government halted the nuclear plans (Event 5, see annex I). In these cases (such as those happened in the former period) the relevant issue is that policy makers changed their orientations and decisions towards concrete nuclear developments due to political strategies of the electoral arena, even contradicting themselves and their explicit political principles.

In Sweden, the issue of nuclear weapons became a contested political issue for the receptors when the knowledge about the military aspects became more generally known (event 1, see annex I). But at the political level people that were in favour of research on nuclear weapons also argued that this would act as a deterrent by showing the world that the country was capable to build these. On the other hand, the public debate was somehow neutralized by the regulators and political parties due to the coming elections, reaffirming that this was a controversial issue for the political scene (event 1, see annex I). Besides, in Sweden national independence of energy supply was an aspect of nuclear development subordinate to the competitiveness or reliability of the nuclear energy sector (General narrative, see annex I).

The UK is the country where the public authorities and regulators seemed to have been trying to achieve more trust from the public. Although in the first period (1950-1970) the Windscale fire (event 3, see annex I) had little impact on the nuclear power programme at the time, the combined impact of the incident itself, the government's handling of it, and the secrecy surrounding it, led to a decrease in trust in the institutions involved. This generated notable criticism of the government and changes to the manner in which nuclear power was debated and perceived. Besides, one of the arguments mentioned in the UK report related to the reduction of dependency on foreign energy sources (considered also more expensive) (event 2, see annex I). Nuclear energy offered a chance to reduce British reliance on coal and expensive imported oil

amongst concerns of air pollution and a fuel crisis. During the second period (1970-1990) the public authorities emphasized the need of guaranteeing the choice of the safest available nuclear reactor technology (event 4, see annex I). In the third period (1990-2015), some receptors showed a lack of trust in the management performed by private companies following a culture of secrecy (Event 7, see annex I). The receptors demanded more public information about power stations, and this was especially the case in local communities affected.

In Ukraine, during the second period (1970-1990), the affected population (receptors) perceived a lack of information flow regarding the Chernobyl accident (General narrative, see annex I) and even a falsified narrative about how the management was done (Event 1, see annex I). Public trust seemed severely damaged in Ukraine by the event and the associated secrecy surrounding its consequences and management, which played a key role in the resistance of Ukraine against Soviet rule. However, key changes in the political scene in Ukraine led also to changes of public attitudes towards nuclear power, in the sense that they reacted less once Ukraine was constituted. The antinuclear local mobilization from the receptors contributed to the moratorium on the construction and commissioning of new nuclear power units (Showcase, see annex I), with many experts proposing informational and educational work with receptors as a method to address such mistrust, reflecting the knowledge deficit model of gaining support through the provision of scientific facts to create a better informed public and therefore overcome societal concerns. Regarding how regulators managed information, the receptors perceived a lack of flow of information to act adequately in an emergence status. In general, there were great fears the nuclear plant may collapse or decay and trigger another nuclear incident. This lack of management and/or coordination from the authorities in dealing with the accident could be noticed among the receptors (event 2, see annex I). In the third period (1990-2015), at regulators level, the debate in Ukraine was on the European West-East distrust situation, as western partners should assist Ukraine on exchange of closing Chernobyl remaining reactors (at the time of the accident six RBMK reactors were in operation or under construction at the Chernobyl site – to be noted that this technology is no more used in Ukraine where nuclear power supplies about 50% of electricity production). Ukraine officials were disappointed by the Western partners who, according to the Ukrainian side, failed to fulfill their 1995 commitment to assist the country in exchange for closing the Chernobyl plant. For instance, the Western side didn't provide the funds

necessary to complete K2-R4 (Event 4, see annex I). Besides, after Ukraine gained political independence, the perception of the Chernobyl NPP turned from being a sign of colonial domination by Russia into an important source of the electricity production that crucially contributed to the nation's economic survival and independence (Event 3, see annex I). The public authorities hoped that nuclear power would ensure high degrees of independence from Russian oil and gas, but they had not been able to break free of this relationship because of heavy dependence on Russian nuclear services (as their nuclear development was linked to the former soviet technology) (General narrative) (although the fuel for Ukraine NPPs was designed and produced by Russia, but Euratom has recently funded projects aiming at the production of fuel by Western companies).

. In order to achieve a better public image, the Promoters of NPP tried to introduce rules of transparency and accessibility to the nuclear sites (Event 5, see annex I).

According to the USA SCR, the regulators (the Atomic Energy Commission, AEC) yet from the start (by the late 1940s and 1950s) suffered from two weaknesses in the effort to promote nuclear power: first, in early times the AEC commissioners were fully beholden to military interests; second, the agency appeared to be "captured" by the industry it was meant to regulate (General narrative, p. 6-7). Other sources of distrust were found in the promises made by Promoters and Regulators that later were not fulfilled or turned out to be false. For instance, yet in spite of the precautions in the design and construction of the Fermi reactor, and in spite of the reassurances by the scientists that a serious accident could not happen, one did occur (Event 1, see annex I). In sum, since early times (period 1950-1970), and according to its critics, the regulator too often assumed a promotional, not sufficiently regulatory role, which could lead to the public distrust. In the second period (1970-1990), according to the USA SCR, the regulator (AEC-NCR) (AEC dissolved in 1975 and since then the NRC became the independent regulator). was seen as low trustworthy due to several non-congruent behaviours. First, for its supposedly inefficient functioning ("the NRC routinely licenses plants on extremely thin financial, safety, and environmental evidence") (General narrative, see annex I). Second, in the aftermath of the TMI accident, the Kemmeny Report indicated the poor regulatory operations of the NRC (Event 3, see annex I). Finally, the Regulator (NRC) lost a great deal of trust among people when it accepted

an industry-sponsored emergency evacuation plan, in a place where geographic and demographic characteristics of the seacoast area make it difficult to evacuate safely under any conditions (Event 4, see annex I). In the third period, in the USA some critical groups (such as the Union of Concerned Scientists) considered that the license-renewal process "was designed to limit the scope that could be considered, specifically the ability of the public to intervene" (Showcase, see annex I), fostering distrust among some social groups. At the same time, supporters of nuclear energy emphasize the facts that nuclear power will help secure US energy independence (General narrative, see annex I). However, in the early 1990s the United States and Russia reached a landmark agreement that would turn former Soviet nuclear weapons material into fuel to power America's civilian nuclear reactors. The "Megatons to Megawatts" partnership provided enough fuel to generate 10% of America's electricity needs (Appendix 4, see annex I), and it could be interpreted as a way of losing a bit energy autonomy (a very small proportion but that moves the country away from utopian ideal of self-sufficiency in times of peak-oil and potential energy crises).

In general, the diachronic analysis of all the case-studies countries shows that the political-institutional factors were more present in the second period (1970-1990), when the popular mobilization against nuclear energy increased. In any case, the content of these factors are more or less similar in all three of the temporal phases considered.

3.3. Socio-cultural factors underlying nuclear energy: key findings

The socio-cultural dimension refers to several factors identified by two different theoretical approaches: the Psychometric paradigm and the Cultural Theory of risk. It is well known that some factors can influence individual risk responses, such as unwillingness to be exposed, familiarity with the risk, the controllability of the consequences, the deferred appearance or not of damage in time or space, etc. As well, risk could play a role in the maintenance of a certain social order, therefore, certain groups emphasise the perception of certain risks over others generating different social identities.

The main socio-cultural factors found in the analysis are (table 6):

- Conflicts of values: social conflicts related to preferences for different lifestyles, different economic and social development models, different attitudes towards pacifism / warmongering that nuclear development may entail, even concerns about how future generations will judge current ones because of their management of nuclear energy, etc. These are elements that respond to different ideologies or ways of understanding how society and its evolution should ideally be.
- National scientific pride (and national military pride too)
- Territorial identity conflicts (territorial comparative grievances; conflicts between economic activities and land uses, etc.)
- Subjective attributes of risk: perception of difficulty of calculating risks, perception of low controllability of risk, unwillingness of being exposed, familiarity with the technology (and coping with similar risks in the past).

The concrete content of these factors for each country can be seen in the Annex I.

These factors are also unevenly distributed among the different countries, and therefore would help to explain the different social responses to nuclear energy. For instance, national pride was a very predominant factor in Finland, whereas territorial identity conflicts were very present in Spain.

Table 6: Socio-cultural factors shaping public perceptions identified in the selected case-studies SCRs, by periods.

1950-1970	1970-1990	1990-2015
B Conflict of values (life styles / development models) (fear of being accused by future generations)	B Adherence to values (development models / ideology)	SP Familiarity with the risk (coping with similar risks in the past) (2)
B national scientific pride	F Conflict of values (life styles / development models / ideology)	SP National scientific pride (2)
F Adherence to values (development models)	G Conflict of values (life styles / how to be seen by future generations)	SP Territorial identities conflicts (territorial comparative grievance)
F Conflict of values (life styles / development models)	G Conflict of values (perceived increasing risk of war)	SP unwillingness to be exposed
F Low calculability of risk	G Low calculability of risk	SW Familiarity with the risk
F national scientific pride (2)	G Low controllability of risk	U Conflict of values (political identities)
		U Conflict of values (political

F Threats to local identities F unwillingness to be exposed SW Conflict of values (perceived increasing risk of war) SW national scientific pride UK Conflict between economic activities and land uses UK Conflict of values (perceived increasing risk of war) (2) UK Low controllability of risk UK national scientific pride (and military) US Conflict between economic activities and land uses US Conflict of values (life styles / development models / ideology) US national scientific pride (and military)	G territorial comparative grievance G Territorial identities conflicts (political territorial borders) SP Conflict of values (ideology) SP Conflict of values (political identities) SP Territorial identities conflicts (conflict between economic activities and land uses) SP Territorial identities conflicts (territorial comparative grievance) (2) SW Conflict of values (life styles / development models / ideology) SW national scientific pride SW Territorial identities conflicts (conflict between economic activities and land uses) U Conflict of values (political identities) (2) US Conflict of values (political identities) (risk of war)	identities)

Source: own depiction based in the in-depth analysis of the SCRs. Each line means that this factor is mentioned in the respective SCR, sometimes more than once (numbers in brackets) (Code: B = Bulgaria; F = Finland; G = F.R.Germany; SP = Spain; SW = Sweden; UK = United Kingdom; U = Ukraine; US = United States).

Among the SCRs there are also several clues of classical 'attributes of risk' (in terms of the psychometric approach), such as 'unwillingness' to be exposed to a potential risk (cases in Finland and Spain), the 'perception of low controllability of the risks of the technology' (cases in Finland, F.R Germany and UK), and the 'familiarity with the technology' (cases in Spain and Sweden). While the first two attributes are expressed overall by different sectors of receptors, the last one ('familiarity') is used by promoters and regulators to explain the absence of social mobilization in certain cases, or sometimes to convince the public of the inadequacy of their opposing attitudes towards a certain nuclear project (as the case of Sweden, event 5: "the

population were already accustomed to nuclear facilities and did trust the nuclear industry") (see annex I). In general, it reflects a certain distance between 'experts' and lay people's perceptions. The few available data in the SCR does not allow to evaluate the time evolution of these analytical dimensions.

In several countries nuclear energy became a symbol of scientific progress and, therefore, of 'national pride', especially in Cold War times, but also later. In this context, national scientific pride became an argument to be for or against nuclear developments. Nevertheless, there is still another side of that 'national pride': some social groups holding positions contrary to nuclear energy are concerned about the image that future generations will have about their countries for having supported nuclear developments in the past (the SCR of Bulgaria and Germany expressed these concerns). Being in support or against nuclear power would imply to be treated as a traitor or as a hero, which is another way of thinking of nuclear developments from an identity frame.

Local communities can sometimes be reluctant to nuclear siting decisions for a variety of reasons; 1) the project did not fit into its development plans, 2) it increased conflicts related to land uses, 3) the local economic activities felt threatened by the nuclear project, 4) the local social fabric (social networks and local identities) could potentially be modified due to the impact of the nuclear project, 5) or regional identities fight against central government decisions in the territory. These negative attitudes can in some cases be described as NIMBY protests, but not always.

Nuclear programs have played a political role in different countries at different times. During the Cold War times by positioning the country in the international sphere (Finland case), or framing the internal national images (USA case). In times of democratic transitions as a way of positioning internal parties in the impending elections to come: in the Spanish case, nuclear developments were symbolically linked to the dictatorship regime; in the Ukrainian case, Chernobyl became a symbol of colonial power and fuelled the independence movement.

Going through the selected case-study contents would help to better understand the countries' differences:

In the Bulgaria SCR, sometimes the actors' discourses have to do with the collective identities they seek to promote. For instance, in the first period (1950-1970) some actors justify their support for nuclear energy because it was a symbol of scientific progress and, therefore, of national pride (Event 1, see annex I). This can be understood as a collective identity that some actors would like to be shared by all national actors (mainly Promoters and Regulators). Instead, Receptors fear to be accused by future generations for their support of nuclear developments. During the second period (1970-1990), the dependency on the Soviet Union's nuclear technology was presented as a symbol of brotherhood between Communist countries (Event 2, see annex I). And during the third period (1990-2015) the public perceptions in Bulgaria seem to have been affected by the change of political and social model due to the fall of the communist regime (Event 3, see annex I), in a time when the Green organization Ekoglasnot acted as catalyser of people concerns on nuclear power, becoming a stake in times of political and social changes.

In the Finnish SCR, during the first period (1950-1970) some word about the difficulty of calculating nuclear risk, and the correlative distance between experts and lay people, can be found ("engineers and scientists tend to be overly optimistic. (…) Anti-nuclear groups spread alternative truths about the nuclear risks") (Event 5, see annex I). Also the concept of 'unwillingness' to be exposed to risk explains some of the public attitudes against nuclear infrastructures (from the receptors' side) (as such the case of the residents of the town of Loviisa, where a NPP was built) (Event 5, see annex I). At the same time, the Finnish SCR insists several times in the key role played by the 'national scientific pride' in justifying the nuclear projects decisions. Nuclear program helped in establishing high quality scientific and technological research and education institutions, and allowed Finnish experts and politicians to participate in key international conferences during the Cold War (General narrative,; events 1 and 2; see annex I). Additionally, in the process of finding a place for the first nuclear power plant in Finland (1966), land owners and community politicians were suspicious about the search for siting a nuclear energy installation, and several municipalities were reluctant to the siting decision because the project did not fit in their future development plans (Event 5, see annex I). In any case, the Finnish SCR shows that the nuclear program played a political role in the international position of the country, located in between West and East, helping in building a Finnish identity adapted to the geopolitics of the Cold War (General narrative,and event 1; see annex I). The

report also shows how (in the early 60's) it was not easy to separate the civilian and military applications in nuclear technologies (event 3,and event 6; see annex I). This lead to the opposition movements to be critics with the nuclear program appealing to anti-nuclear weapons treaties and laws. Later, during the period 1970-1990, some concerns about the siting of nuclear power plant right next to large urban areas were reported (event 6, see annex I). In the case of Kopparnäs community (40 Km away from Helsinki) it was argued that six large scale reactors would need massive amounts of cooling water and fresh water and also an industrial size infrastructure, which was a great impact for a small community. Besides, it was said that "nuclear power stations would also destroy the image and identity of Kopparnäs" (event 6; see annex I). Threats to local identities were a source of public reactions against installations with potential large impact, as those of nuclear developments. However, according to the Finnish SCR, modernization of Finland received very few critical comments (General narrative, see annex I). Later, environmental movements promoted energy saving, environment protection and new life-styles grounded in the idea that less consumption required less energy (General narrative, see annex I). Additionally, in the SCR is said that there is collective memory that shapes the 'uneasy' interaction between Finland and Russia/Soviet Union regarding nuclear energy issues (Showcase, see annex I).

In the F.R. Germany report it is said that in early times (1950-1970), military strategic considerations influenced siting decision; and this pointed out to military aspects of the peaceful use of nuclear power in early West Germany. "Although the scientific community tried hard to present nuclear science as a strictly civilian endeavour, not least to strip it of its historical origins in the so-called "Uranverein" (a project to develop nuclear weapons) under National Socialism, military rationales did play a substantial role in West Germany's early nuclear history" (Event 1, see annex I). During the second period (1970-1990), public authorities and receptors in the F.R. Germany perceived low controllability of the risks of the technology in the case of the proposed fast breeder sodium cooled nuclear reactor (SNR-300) construction in Kalkar (Showcase, see annex I). The critique to the project was even greater after TMI because a reactor of this type was seen not easily to be taken under control and therefore involved more risks. Concerning public authorities, some of them considered the commissioning as irresponsible, because the risks were ultimately not calculable. Additionally, in the SCR it is said that being in support or against nuclear

power is a matter of how to be seen by future generations: “Those who did not wish to be seen as traitors and followers had a duty to oppose nuclear power” (General narrative, see annex I), which implies the generation of an identity shaped by the pro or anti attitude. During this same period, the pilot-scale project SNR 300 motivated promoters due to the limited uranium reserves and regulators hoped for an efficient utilization of the minerals by building this reactor. However very soon, the search for a site raised concerns among receptors who demonstrated against the project, and many of the demonstrators even came from the Netherlands as the chosen site was close to the country’s borders (Showcase, see annex I). In this case land conflicts were related to political territorial borders. Also in the F.R. Germany, by locating the planned repository site in the economically underdeveloped hinterland the government tried to avoid opposition against the project, which failed because the level of protest increased (Event 4, see annex I).

In Spain, several dimensions of technological colonialism (at international level) and imposition over local society (at national level) were discussed during the second period (1970-1990) (Showcase,and Event 1; see annex I). In both cases we find the notion of “unwillingness” to be exposed to a risk, one of the key factors underlying public responses. Additionally, promoters and public authorities expressed their views that people living near a NPP were coping with similar risks in their everyday life (such as road accidents) in order to minimize its importance (event 1, see annex I). Perception of catastrophic risk, very different from that expected by the experts, can also be detected (event 3, see annex I). During this same temporal period, territorial/regional identities played a crucial role in accepting or rejecting nuclear projects in Spain. In some instances, when the central government or other centralised authority took the location decision, the opposition to nuclear power became a fight for regional identity vs. the central government and the economic power imposition in the territory. This happened, for instance, with the early attempts to locate the first NPPs in Spain (General narrative, see annex I), or with the Valdecaballeros case (Showcase, see annex I). In many cases Spanish environmental movements (receptors) denounced the unequal distribution of risk among territories, with the area treated as a landfill of dangerous and/or with large impact infrastructures (Showcase, Event 2). In some way there is also a conflict between a rural world which feels forgotten and an urban world that holds the main benefits. From the Receptors opposing the NPP (as the case of Ascó, in Spain), it is argued that that territory concentrates already too many industrial risk facilities

(petrochemical, nuclear, etc.). Other argument is that it is a rural area disadvantaged, in crisis and losing population, which instead of giving a positive development reserve a role of landfill of what favored areas do not want (perception of inequality, comparative grievance). Behind the conflict of Ascó there is a tension between a rural world which feels being forgotten and the urban world that holds the main benefits. Additionally, in the case of Spain many of the anti-nuclear movements are difficult to distinguish from the anti-dictatorship movements (General narrative, and event 2, see annex I). The fact that the nuclear developments took place during the dictatorship linked symbolically this technology to this political regime. Additionally, the nuclear debate polarized the interrelationships between the actors in the Basque region, where a terrorist group (ETA) made anti-nuclear speech one of their hallmarks (even having been pronuclear in the past, as a way of instrumentalizing the growing public opposition to the NPP sitting processes) (event 3, see annex I). Finally, in Spain there are some perceptions linked to the desire to maintain certain forms of life (such as a rural or fishermen's life) (event 1, see annex I). Another issue is the moral dilemma the anti-nuclear movements in the Basque Country had to deal with, i.e. how much to accept that terrorist violence can be useful for its presumably peaceful purposes (event 3, see annex I). This leads to a strong conflict of values between several actors shaping public perceptions. In the third period (1990-2015), regarding the siting process of a nuclear waste repository, some receptors expressed beliefs about the familiarity of the local communities with the NPP because its presence became already part of their daily life (other nuclear facilities had been in the area), or it is considered as similar risk as any industrial facility (event 5, see annex I). On the other hand, promoters showed themselves proud of their knowledge and experience in decommissioning nuclear installations, as the case of Vandellós I (Event 1, see annex I). Although in this case the Promoters failed in managing the NPP (a serious incident happened in 1989 leading to the closure of the Vandellós I NPP), they try to present themselves as reliable managers, and the failure is presented as a learning opportunity to become better specialists. In this sense, they are proud of their good knowledge and experience in decommissioning the NPP. This argument can be considered as a matter of professional status, as a way of maintaining their place in their social networks. Besides, according to the Spanish SCR, Promoters (and some Receptors) of a nuclear waste repository (Event 5, see annex I) considered that nuclear developments would lead the country to scientific excellence,

allowing high level scientific jobs in the area. During this third period new warnings on unequal distribution of risk among territories have been detected in Spain, with some areas feeling being treated as a landfill of dangerous and/or annoying infrastructures. For instance, the siting process for a nuclear waste repository has unleashed a sharp political contest between several social movements and public administrations, with a large dose of territorial and social identities in between (event 5, see annex I).

In Sweden, protective defence purposes were mentioned in the first period (1950-1970) (event 1, see annex I). Among regulators the controversy was based on the purpose for the atomic weapons research (how research could be conducted). Concerning receptors there was less controversy on this matter; they understood research on how to protect Sweden for the risk of nuclear weapons from other countries (Sweden SCR, event 1; see annex I). The receptors directly related the development of atomic weapons with their security and also with a perceived increasing risk of war. In this sense, opponents of nuclear weapons were concerned by an increase in the risk of atomic warfare affecting Sweden (event 1, see annex I). During the second period (1970-1990), according to the Swedish SCR, one of the arguments to support nuclear developments in Sweden was the importance for the country in terms of its good position in the international community. Thus in 1972 when the Swedish king inaugurated the Oskarshamn plant, he remarked on the importance of this milestone for the country in terms of technological development and the beginning of a new epoch (General narrative, see annex I). Additionally, exploration activities looking for repository sites involved, at local level, specific protests with a NIMBY ('Not In My Backyard') emphasis from the Receptors (event 3, see annex I). This was, however, a first step towards a more general critique of nuclear developments, which included the defence of local territories. One of the objections expressed by some receptors was the need to advance towards other energy models based on renewable sources and efficiency measures (event 2, see annex I), equating to a request for a more sustainable development model, which refers to alternative worldviews. In the third period (1990-2015) the technology', according to the promoters, seems to play a role in the absence of strong opposition ("the population were already accustomed to nuclear facilities and did trust the nuclear industry") (event 5, see annex I).

According to the Ukrainian SCR, sometimes public authorities' responses facing nuclear incidents were framed in a 'war' context against external enemies. This can be seen in the Chernobyl case, treated by the Public authorities as "an external enemy that Soviet people must fight" (Event 1, see annex I). More generally, the use of military rhetoric and images was pervasive in the Soviet media at the time. Soviet troops and military equipment were heavily involved in the Chernobyl clean-up and evacuation operations. In the third period (1990-2015), the anti-Chernobyl protest became part of a broad independence movement that was centred to a large degree on environmental concerns (Showcase, and Event 2, see annex I). Chernobyl became a symbol of colonial power and fuelled the independence movement. However, later public opinion seems to realize that nuclear energy was a condition for national independence, leading to a kind of "reluctant acceptance" (in terms of Bickerstaff et al. 2008) of it. The issue of "reluctant acceptance" for nuclear power like a condition for national survival was raised among receptors (Event 5, see annex I), even if the negative consequences of Chernobyl continue to haunt Ukraine, some of the public opinion still think that nuclear energy is the condition for the national survival.

In the UK, since the first period (1950-1970), the public perception of the controllability of the technology became a key factor in social acceptance, according to the Promoters and Regulators. In the case of Windscale fire a governmental report claimed that the cause of the incident was a "human error by well-trained but unfortunate plant staff", which informs of a weak point on the confidence granted to the controllability of the plant (Event 3, see annex I). During this time, in the UK the nuclear developments (even for military purposes) were justified by Promoters and Regulators as a matter of prestige and British supremacy in the international community (event 1, see annex I). For the government, the major reasons for going ahead were prestige, and to maintain Britain's place at the 'top table' of international politics. However, the Windscale event raised some concerns about potential pollution of local food products among the Receptors (Event 3, see annex I). This recalls to a conflict between social and economic activities and land uses in the area where the NPP was located. But in the UK maintaining the country's place at the 'top table' of international politics in Cold War times seems to have been the motive for appealing to nuclear weapons (Event 1, see annex I). Although the issue of Britain's nuclear weapons became controversial, publicly and politically, opinion on the topic varied from

supporting unilateral disarmament to supporting continued development of nuclear weapons. On the receptors' point of view, public reactions were towards the use of nuclear weapons but not on the nuclear power, in a period of public trust on political institutions. However, some early movements started with a growing concern about nuclear weapons throughout the 1950s. Later periods seemed to follow the same patterns.

In the USA, since the first period (1950-1970), some words were devoted to the special prestige of scientists owing to their success in the Manhattan Project and in role in the unfolding Cold War military-industrial struggle with the USSR (General narrative, see annex I). Besides, according to the USA report, the Enrico Fermi NPP licensing process may be the first time in US history that public individuals began to oppose nuclear power. It is said that the head of the United Auto Workers became convinced that the NPP would endanger Detroit, the auto industry and auto workers themselves, and litigated against the station (Event 1, see annex I). It describes a conflict between different economic activities in the same territory, by defending concrete ways of living. Additionally, in Cold War times being pro or against nuclear energy was sometimes interpreted as being pro or against the national sentiments. For this reason, some cases of early protesters were qualified (and pursued) as communists. The East-West competition at that time seemed to frame the whole nuclear debate in the USA (General narrative, and Showcase, see annex I). In the USA report it is said that some environmental movements (as such Abalone Alliance) were critical to the direct relationship between civilian and military nuclear power (Event 2, see annex I).

3.4. Engagement activities in the selected case-studies

Based on the flow of information between participants and promoters, (i.e. those who have commissioned a particular engagement initiative), we have differentiated between three engagement types: public communication, public consultation, and public participation. In addition, we suggest designating engagement actions initiated by the public and directed towards the regulators or nuclear companies as 'public-initiated engagement.'

The analysis of the SCRs shows a great variety of engagement mechanisms used by the selected countries over time (table 7). During the early phases of nuclear developments, communicative activities predominated, while after the '90s, more participative approaches and mechanisms arose.

Table 7: Engagement activities identified in the selected case-studies SCRs, by periods.

1950-1970	1970-1990	1990-2015
B Secrecy	B Communication: disinformation (2)	B Consultation: public opinion surveys
F Consultation: public opinion surveys	B Public-initiated: Public mobilization (protests)	B Consultation: referendum
F Participation: small group of decision makers) (low democracy mechanism)	B Secrecy (or restricted communication)	SP Communication: informational visitors' centres (educating the public)
G Communication: promotion of "research centres"	G Public-initiated: administrative and legal litigation	SP Communication: Internet media (website and social networks)
SP Public-initiated: administrative and legal litigation	G Public-initiated: collecting signatures	SP Communication: Internet media (website)
SW Participation: study group representing both opponents and proponents	G Public-initiated: Public mobilization (protests)	SP Participation: local informative committees (official)
SW Public-Initiated: collecting signatures	SP Communication: classic mass media (national / local)	SP Participation: local Joint Commissions
SW Public-Initiated: scientists writing articles in newspapers and contacting politicians	SP Communication: news for the media, press conferences	SP Participation: voluntary candidature process (for siting a repository)
UK Communication: films presenting nuclear energy	SP Consultation: public opinion polls	SP Public-initiated: Public mobilization (local protests)
UK Participation: public meetings	SP Public-initiated: collecting signatures	SW Consultation: public hearings
US Communication : films about nuclear energy	SP Public-initiated: press interventions, books, support of celebrities	SW Consultation: referendum
US Consultation: surveys on public opinion	SP Public-initiated: Public mobilization (mass protests) (violence)	SW Participation: Public hearings, informative meetings and debates
US Public-initiated: administrative and legal litigation	SP Secrecy (or restricted communication)	SW Participation: voluntary candidature process (for siting a repository)
	SW Communication: classic mass	U (Public-Initiated: alternative

US Public-Initiated: public opposition groups US Public-Initiated: public protests US secrecy	media SW Consultation: public opinion surveys SW Consultation: referendum SW Participation: information meetings with experts of pro and anti-nuclear SW Public-initiated: collecting signatures SW Public-initiated: Public mobilization (mass protests) (3) U Communication: educational work U Communication: informational visitors' centres (educating the public) U Consultation: public opinion surveys U Public-initiated: Public mobilization (local protests) U Secrecy (or restricted and/or biased communication) (2) UK Communication: classic mass media (advertising campaign in newspapers) UK Consultation: public opinion surveys UK Participation: public inquiries UK Public-initiated: Public mobilization (protests) US Communication: classic mass media US Consultation: public opinion surveys US Consultation: referendum (proposed) US Public-initiated: Public	hearings) U Communication: classic mass media (press-releases) U Communication: information centres (educational activities) (2) U Communication: rules of transparency and accessibility to the nuclear sites U Consultation: public opinion surveys U Consultation: referendum (local) U Participation: Public hearings, informative meetings and debates U Public-initiated: collecting signatures U Public-initiated: public hearings and roundtables UK Consultation: citizen's panels and focus groups US Consultation: public opinion surveys US Public-Initiated: activists sending letters, making protest skits

	mobilization (mass protests)	

Source: own depiction based in the in-depth analysis of the SCRs. Each line means that that activity has been mentioned in the respective SCR, sometimes more than once (numbers in brackets) (Code: B = Bulgaria; F = Finland; G = F.R.Germany; SP = Spain; SW = Sweden; UK = United Kingdom; U = Ukraine; US = United States).

The analysis shows a long list of engagement practices and mechanisms, evolving through the different temporal phases.

During the first period (1950-1970), the communicative practices related to the expression of nuclear promises (popular films, etc.) predominated, but some countries also activated consultation processes (public opinion surveys in UK, USA, Finland) or participative mechanisms (public meetings in the UK, a study group in Sweden). These countries were facing public opinion pressures due to earlier incidents (Windscale in the UK, Fermi in the USA) and/or nuclear weapons debates.

In the second period (1970-1990) communicative strategies continued but also cases of secrecy and misinformation related to nuclear incidents and accidents appeared (i.e. the case of Chernobyl was poorly handled in communicative terms by public authorities in Bulgaria and Ukraine, with restricted and biased information). But the most relevant engagement activity during this phase is the increase of consultation activities, especially through public opinion surveys (that became periodic in most of the countries), information centres and meetings (as in Ukraine or Sweden) or even referenda (done in Sweden, and proposed in some states of the USA). In the UK, the public inquiries mechanism played an interesting participative approach. Public-initiated engagement rose dramatically during this period in all of the countries (the SCRs refer to mass mobilization protests, collected signatures, press interventions, etc. from local communities and national social movements).

The third period (1990-2015) is characterised by an intensification of the consultation mechanisms: public opinion surveys, referenda (mainly at the local level, in Bulgaria, Sweden, and Ukraine), participative processes as public hearings (in Ukraine, Sweden), local informative committees, local joint commissions (Spain), voluntary candidature processes to siting nuclear installations (as in Sweden, Spain), citizen's panels (UK), etc. Regarding communicative

mechanisms, during this phase Internet began to play a key role in transmitting information to the public, allowing more transparency and accountability of the nuclear sector, and also being used for consultative purposes.

4. Concluding remarks

According to our theoretical proposal, the perception of nuclear energy is composed of several dimensions that, in each specific case, may have different weights in their influence on the opinions, attitudes or behaviors of the population. From this perspective, it would not be correct to consider that there is one population in favor of nuclear energy and another against it. Rather, situations can occur of people who are in favor in one dimension and against in another at the same time. That is, we can find people or social groups considering that nuclear energy is a benefit because it guarantees an energy flow and facilitates national independence, while, at the same time, considering that it is not easily acceptable because it involves certain environmental risks, or because it grants economic benefits to a company with a bad image because suspected of being corrupted. In each empirical case, the balance between these weights is moderated by the political-institutional factors producing social trust, and by the socio-cultural factors shared by large social groups.

Nuclear energy is a technology with different degrees of public acceptance in different countries. Our analysis is based on the assumption that the different public acceptance depends on the perceived risks and benefits (which revealed to be very similar among the case-studied countries), and that these perceived risks and benefits depended on social trust of institutions in charge of managing and/or regulating it (political-institutional dimensions), all of which are a function of a series of socio-cultural factors generated by the social climate over time. Further, the concrete articulation of this set of factors in each case is related to different engagement activities deployed in each country.

Regarding the common features about perceived risks and benefits, large part of the references to health concerns related to nuclear power were reported in the period 1970-1990, although some fewer references can also be found in other periods. This tends to coincide with the period of higher social mobilization against nuclear projects around the world. This means that most of the protests used to be based on health and environmental arguments, although there could be other dimensions involved that were not obvious (not explicit).In similar terms, although roughly absent during the first period of the nuclear development, since the 70's the environmental risks

became a dominant argument among all the involved 'actors'. Affected people (receptors) highlighted in a broad sense the potential environmental impacts of nuclear facilities. On the contrary, we identified only a few references to these impacts on the promoters and regulators side, usually hinting at positive impacts such as mitigating climate change. These arguments increased since the 90's, and according to this interpretation, nuclear power would play the role of a preventative measure in mitigating environmental risks associated to climate changes.

Economic benefits and risks seem to be more present during the first and the second periods, while losing some importance during the third. The high cost of nuclear energy projects has been an argument used by many actors both to justify their reluctance in investing in these projects and cancel on-going projects, but also to justify continuing with a project once it had been initiated. Arguments about the high costs of nuclear energy were mainly publicised by receptors, and the increasing regulations and safety requirements became a driving factor of the increased resources needed by the nuclear sector. Additionally, the technological development alongside the trend towards privatisation, concentration and internationalisation of the nuclear energy industry eventually could undermine the effectiveness of national regulatory structures (as hypotetized by Strandberg & Andrén, 2009), which leads to highlight the importance of the political-institutional factors and the socio-cultural factors in influencing the public acceptance of nuclear energy developments.

The work of Strandberg and Andren (2009) explains how privatisation and concentration of the nuclear power industry has put an end to national ownership in many countries, thereby complicating institutional regulation of radioactive waste management. According to them (Strandberg and Andren 2009: 892): "The technological configurations required by leading-edge research can be expensive and are often the product of regional cooperation. Thus, one must also take into consideration the dynamic interaction between national and international contexts that affects technologies, principles and organisations. The value of responsibility is embodied in the internationally accepted principle that each country must manage its own HLW. National responsibility as a principle is currently being challenged by the abovementioned global developments, while the question of how to uphold it on a long-term basis remains unanswered."

The articulation of this complex set of factors in our analysis leads to the emergence of several groups of countries (table 8).

The overview allows to see how are distributed the political-institutional factors: First, the 'institutional trustworthiness' is a factor widely distributed among all the countries (low in all the countries, except in the UK and Finland). The 'political games' are relevant in all the countries except in UK and the USA. And the 'dependency' factor is present overall in the nuclear debates of Bulgaria, Ukraine and Finland.

Regarding the socio-cultural factors: 'Conflict of values' are seen in all the countries. 'National pride' is relevant in all the countries execpt in Spain and Germany. And the 'territorial-identity conflicts' are present overall in Germany, Spain and Sweden.

Table 8: Distribution of the main political-institutional and socio-cultural factors, and engagement strategies.

Factors underlying public perceptions of risks and benefits of nuclear energy		B	U	F	G	SP	SW	UK	US
Political-institutional factors	Low institutional trustworthiness	II (2)	II	III(+)	II	II (3)	II	I II (+) III	I (2) II (4) III
	Political games	II	III(2)	II III	II	II III	I		
	Dependency of/on other countries	III (2)	I III	I II					III(2)
Socio-cultural factors	Conflicts of values (ideology, etc.)	III (2)	I II	I (2) II	II (2)	II (2)	I II	I (2)	I
	National scientific pride	II (2)	I	I (2)		III	I II	I (2)	I II
	Territorial identity conflicts			I	I (2)	II (3) III	II		I
	Subjective attributes of risk			I (2)	I (2)	III(3)	III	I	
Engagement strategies	Secrecy / selective communication	I II (3)	II (2)	I		II			
	Public communication		II (2) III(4)		I	II (2) III(3)	II	I II	I II

	Public consultation	III (2)	II III(2)	I	II	II	II (2) III (2)	II III	I II (2) III
	Public participation		III	I		III(2)	I II III(2)	I II	
	Public-initiated engagement	II	II III(3)	II	II (3)	I II (3) III	I (2) II (4)	II	I (3) II III

Source: authors, based in the in-depth analysis of the SCRs. Each line means that that factor or activity has been mentioned in the respective SCR, sometimes more than once (numbers in brackets) over the different historical periods (I= 1950-1970; II= 1970-1990; III= 1990-2015) (B = Bulgaria; F = Finland; G = F.R.Germany; SP = Spain; SW = Sweden; UK = United Kingdom; U = Ukraine; US = United States).

According to table 8, we are clustering the case-study countries in the following classification.

1) Countries where the geo-strategic dependencies predominate

First, one of the proposed groups is made up of the Eastern countries (Bulgaria, Ukraine) and, to some extent, Finland. These countries are characterized by high and medium public acceptance of nuclear energy over time, sharing a particular position between historical Eastern and Western worldviews and geo-strategic tensions, which appears to have influenced public perceptions on nuclear energy.

As it has already been said above, the main arguments on perceived risks and benefits in these countries are the same as the rest of the analysed countries (concerns about safety and accidents, radiation pollution, economic costs, etc.). However, these public perceptions are conditioned by a set of key facts shaping the loss of trust in institutions (regulators / promoters), such as the following political-institutional factors.

The dependence on other countries conditioned the decisions on nuclear projects (not only in early times, but also in recent times). The particular historical relationship of these countries with the USSR/Russia has framed the public perceptions of nuclear energy (in the sense that they were energetically and technologically dependent countries, and in their independence processes the nuclear energy played a key role), a technology that in the past and over time has generated

a high degree of dependency (from Russia) and, at the same time, is necessary to ensure the essential energy supply for the modern countries' development. (It should be said that nowadays there are Western companies able to provide assistance/maintanance/services for Russian-designed reactors, but regarding its costs Russia is still very competitive).

The secrecy maintained (by the public authorities) during the Chernobyl accident gave rise to distrust among large sectors of the public. This factor had a great influence at the end of the second period (1970-1990), with long-range political consequences.

Following the fall of the USSR, the visible discrepancies in the public sphere between national and international institutions maintained very different opinions with respect to nuclear projects. For example, the minimum criteria required for nuclear safety in Bulgaria, the role of nuclear energy in the nation's economic survival in Ukraine, and in a more general discussion between pro and anti-European parties in Finland. An instrumental use of nuclear energy by the political system is observed in all these countries, especially during the third period (1990-2015).

Finland, though showing a lot of similarities with Bulgaria and Ukraine regarding the mentioned factors, presented some key differences. These include a strong internal public opposition to nuclear energy due to commitments with anti-nuclear weapons treaties, and also a widespread public perception of public authorities as institutions fully committed to public interest (which leads to high levels of trust in regulators / promoters of nuclear projects).

Regarding the socio-cultural factors, the key role played by the 'national scientific pride' in justifying nuclear projects should be highlighted (especially in Bulgaria and in Finland). Adherence to certain political identities values are also present in the socio-cultural arena. For example, in early times nuclear technology was presented as a symbol of brotherhood between Communist countries; and with regards to the Chernobyl case, the Public Authorities treated it as "an external enemy that Soviet people must fight." In fact, the use of military rhetoric was pervasive in the Soviet media at that time, when soviet troops and military equipment were heavily involved in the Chernobyl clean-up and evacuation operations.

In recent years, some socio-cultural factors related with ideal social models appear to be conditioning a less positive view of nuclear energy. For instance, in Bulgaria some social sectors

were afraid of being accused by future generations of supporting nuclear developments, which can put pressure on a certain population to position itself negatively against nuclear energy. In Finland ecological modernization ideas such as the promotion of energy saving strategies, or new lifestyles grounded on the idea that less consumption would require less energy, are also affecting public attitudes against nuclear power among some people.

However, some differences also arise when comparing the three eastern European countries. In Ukraine, the anti-Chernobyl protest became part of a broad independence movement, although the issue of "reluctant acceptance" for nuclear power as a condition for national survival was raised among receptors (even if the negative consequences of Chernobyl continue to haunt Ukraine). In Finland, some local municipalities were reluctant to the siting decision because the nuclear project did not fit into their future development plans, and was perceived as a threat to local identities.

In these countries the decision of using nuclear energy was the result of historical and geo-strategic decisions, leading to a situation where the perceived benefits (in terms of national independence, pride, etc.) are higher than the perceived risks. Nuclear energy was de facto imposed in the past, but this choice was done for reasons of security of supply and technological development, in an international context where achievements in modern nuclear technologies were part of the (Cold War) race with US.

2) Countries where the instrumental use of nuclear issues in the political arena predominate

A second group of countries would include F.R. Germany, Spain and Sweden. In all three countries public perception of the nuclear issue was used for political and electoral purposes. For instance, in the F.R. Germany and in Sweden, the proximity of political elections affected the decision making in some of their nuclear developments. While in Spain, the political parties changed their opinion about nuclear developments due to political strategies of the electoral arena.

A further source of distrust is the perceived low coherent behaviour of some institutions. The government's unwillingness to seriously consider people's concerns has been detected in some cases, especially in Germany and in Spain as reported by Kirchhof and Trischler (2017, general

narrative, showcase and event 4; see the concrete excerpts in annex I) and Rubio-Varas et al (2017, Showcase, and events 2 and 3; see the excerpts in annex I) respectively. Both promoters and regulators did not tell the complete truth to the public when promoting nuclear development. For example, in Spain (Rubio-Varas et al, 2017) in early times promoters violated certain basic urbanistic rules to build a nuclear power plant, with the governments legalizing it a posteriori.[4] They even went so far as to change laws and regulations ad hoc making the local population feel cheated. In Sweden the loss of confidence in the public authorities could be in some way related to their government's lack of commitment to the results of the 1980 referendum, which has generated some distrust among certain sectors of the population (although there are other sectors more confortable with the government decision).

Although these three countries share some political-institutional factors, they have a base of socio-cultural factors which are quite different from each other. For instance, in the F.R. Germany conflict values revolved around preferred development models and how these could be judged by future generations (for supporting nuclear developments instead of more sustainable energy models), along with ideological debates (concerning the role of nuclear energy in military affairs and potential risk of war). In Spain the main socio-cultural conflicts were centered on the degree of compatibility of land uses and economic activities in some territories, coupled with feelings of territorial grievances (by unequal distribution of risks and benefits among territories). In Sweden, national scientific pride seemed to be one of the main factors influencing nuclear public perceptions (positively, in this case), although at the local level some conflicts were detected in terms of land uses and development models of local communities.

[4] According to Rubio-Varas et al. (2017: 25), "The (nuclear) companies had also hired personnel and began building on site in June 1975 despite the lack of the preliminary reports from the water authorities, the environmental evaluation by the national and regional governments, the proper expropriation of the affected lands, and the required construction permits. Some of these issues were legalized by government decree in 1979, when the government – now democratically elected – gave the definitive authorization for the construction of the plant, which was well advanced already." Other examples of the same strategy is found in event 2 (p. 42 and 45) and event 3 (p. 49). The concrete excerpts can also be found in annex I.

3) Countries where the institutional confidence predominate

A third group of countries is composed mainly of the UK, but due to its common historical steps the USA could be added here. These countries each had very early nuclear development, and in both cases they suffered incidents/accidents which created an impact on public opinion (Windscale in the UK, Fermi or TMI in the USA). In the case of the UK it seems that the measures and the approach that the institutions gave to nuclear management favoured an increased confidence of part of the population. This confidence resulted in a wide perception of good commitment to public interest (high levels of trust in public authorities, appearing to guarantee the safest technology). In recent times, although confidence in public institutions seems to be maintained (regulators, etc.), it is observed that among certain sectors of the population there is growing distrust of the private management of nuclear facilities following a culture of secrecy (according to Butler & Bud, 2017, based on the 2008 Energy White Paper on Nuclear Power, Department for Business, Enterprise and Regulatory Reform). In the USA the relationship between public opinion and promoters and regulators is a bit more complicated since the regulators often seem to act not in accordance with the common interest, but rather in line with the interests of the nuclear industry (according to Josephson 2017, in general narrative, events 1 and 2, and appendix 3; see annex I). Additionally, in the USA the potential energy dependence on other countries has conditioned the decisions of nuclear projects in such a way that the promoters present this energy as the only one that can guarantee national energy autonomy.

Regarding the socio-cultural factors, both countries shared the public perception of conflicts between economic activities and land uses, and conflicts about values related to the use of nuclear weapons and the risk of war. Interestingly, both countries share a strong national scientific (and military) pride, which inevitably influenced the public perception of risks and benefits, as well as the trust in institutions.

In light of this typology, some tentative reflections about engagement processes can be made.

The ‘institutional confidence’ countries (UK and USA) seemed to be the first in promoting communicative strategies to cope with early nuclear incidents, and to spread (broadcast) the

benefits of nuclear developments among the public opinion. Progressively they developed also consultative strategies to measure the public opinion over time and in concrete cases, and were introducing participative mechanisms to deliberate and collect the diversity of voices and points of view on nuclear issues at a local level and at a general level. In general, most of these strategies seemed to be applied in a pro-active way (most in the UK than in the USA).

The 'political instrumental' countries (F.R. Germany, Spain, Sweden) started later following the same path, introducing progressively communicative, consultative and participative processes and mechanisms, but mainly in a re-active way, trying to cope with the massive prostest against nuclear siting of developments. Perhaps Sweden was somewhat different because the idea of national scientific pride and modernization was much present in the public debate on nuclear issues.

The 'national dependence' countries (Bulgaria, Finland, Ukraine) also followed the same path, but especially since they need to manage the information and the public opinion protests after the Chernobyl accident. Distrust in how the public authorities and nuclear promoters managed this serious situation was later balanced by the consideration of nuclear energy as something necessary for the national sovereignty, leading to a kind of resigned acceptance mixed with national pride. The case of Finland is perhaps slighty different because there the trust in institutions has remained quite high throughout all the nuclear period, making the difference with the others.

6. References

Country reports – not yet EC approved – (Source: M-Files Database)

Butler, S., Bud, R. (2017) United Kingdom. Short Country Report (Version February 2017). HoNESt Project Report.

Hristov, I., Tchalakov, I. (2017) Bulgaria. Short Country Report: (Version February 2017). HoNESt Project Report.

Josephson, P. R. (2017). United States. Short Country Report (version February 2017). HoNESt Project Report.

Kaijser, A. (2017) Sweden. Short Country Report (Version February 2017). HoNESt Project Report.

Kasperski, T. (2017) Ukraine. Short Country Report (Version February 2017). HoNESt Project Report.

Kirchhof, A.M., Trischler, H. (2017) Federal Republic of Germany. Short Country Report (Version February 2017). HoNESt Project Report.

Michelsen, K.; Harjula, A. (2017). Finland. Short Country Report (Version February 2017). HoNESt Project Report.

Rubio-Varas, M.M., De la Torre, J., Espluga, J., Presas, A. (2017) Spain. Short Country Report (Version February 2017). HoNESt Project Report.

References

Alhakami, A. S., & Slovic, P. (1994). A psychological study of the inverse relationship between perceived risk and perceived benefit. Risk Analysis, 14, 1085–1096.

Beck, U., Giddens, A., and Lash, S., 1994. Reflexive modernisation: politics, tradition and aesthetics in the modern social order. Cambridge: Polity.

Barthe, Y., 2009. Framing nuclear waste as a political issue in France. Journal of Risk Research, 12(7-8), pp.941-954.

Besley, J. C. (2010). Public engagement and the impact of fairness perceptions on decision favorability and acceptance. Science Communication, 32(2), 256-280.

Besley, J.C., (2012). Does fairness matter in the context of anger about nuclear energy decision making? Risk Analysis 32, 25-38.

Besley, J. C.; Oh, S. H. (2014). The impact of accident attention, ideology, and environmentalism on American attitudes toward nuclear energy. Risk analysis, 34(5), 949-964.

Bickerstaff, K., Lorenzoni, I., Poortinga, W., Pidgeon, N.F., Simmons, P. (2008). "Reframing the nuclear debate in the UK: radioactive waste and climate change mitigation", Public Understanding of Science, 17(2), 145-169.

Candlin, C. and Candlin, S., 2002. Discourse, expertise and the management of risk in healthcare settings. Research on language and social interaction, 35, 115–137.

Chilvers, Jason, and Jacquelin Burgess. "Power relations: the politics of risk and procedure in nuclear waste governance." Environment and Planning A 40, no. 8 (2008): 1881-1900.

Cotton, M. (2017) Nuclear Waste Politics: An Incrementalist Perspective (Routledge, London).

Corner, A., Venables, D., Spence, A., Poortinga, W., Demski, C., & Pidgeon, N. (2011). Nuclear power, climate change and energy security: exploring British public attitudes. Energy Policy, 39(9), 4823-4833.

Covello, V.; Sandman, P.M. (2001) Risk communication: Evolution and Revolution. In: A. Wolbarst (ed.), Solutions to an Environment in Peril. Baltimore: John Hopkins University Press, pp. 164–178.

Cox, L.A. (2008) What's Wrong with Risk Matrices? Risk Analysis, 28 (2), pp. 497-512.

Curtis, P.; Carey, M. (2012) Risk assessment in practice. Durham: Committee of Sponsoring Organizations of the Treadway Commission.

Cvetkovich, G.T. and P.L. Winter. 2003. Trust and social representations of the management of threatened and endangered species. Environment and Behavior 35, 2, 286-307.

Dake, K. (1991). Orienting dispositions in the perception of risk: An analysis of contemporary worldviews and cultural biases. Journal of Cross-Cultural Psychology, 22, 61–82.

De Groot, J. I., & Steg, L. (2010). Morality and nuclear energy: perceptions of risks and benefits, personal norms, and willingness to take action related to nuclear energy. Risk analysis, 30(9), 1363-1373.

Douglas, M., 1992. Risk and blame: essays in cultural theory. London: Routledge

Douglas, M.; Wildavsky, A. (1982). Risk and Culture. Berkeley, University of California Press.

Elam, M.; Sundqvist, G. (2009) The Swedish KBS project: a last word in nuclear fuel safety prepares to conquer the world?, Journal of Risk Research, 12:7-8, 969-988

Espluga, J.; Farré, J.; Gonzalo, J.; Horlick-Jones, T.; Prades, A.; Oltra, J.; Navajas, J. (2009). «Do the people exposed to a technological risk always want more information about it?: Some observations on cases of rejection». In: Martorell, S.; Guedes, C. y Barnett, J. (eds.). Safety, Reliability and Risk Analysis. London: CRC Press. Taylor & Francis, 1301-1308.

Espluga, J.; Farré, J.; Gonzalo, J. y Prades, A. (2014). "Factores que inhiben la movilización social: El caso del área petroquímica de Tarragona" [Factors inhibiting the social mobilization. The case of the petrochemical area of Tarragona]. Revista Española de Investigaciones Sociológicas, 146, 191-216.

Fahlquist, J.N.; Roeser, S. (2015) Nuclear energy, responsible risk communication and moral emotions: a three level framework, Journal of Risk Research, 18:3, 333-346

Fischhoff, B.; Slovic, P.; Lichtenstein, S.; Read, S. y Combs, B. (1978). "How safe is safe enough?: A psychometric study of attitudes towards technological risks and benefits". Policy Sciences, 9 (2), 127-152.

Flynn, J.; Slovic, P. y Mertz, C.K. (1993). «Decidedly different: Expert and public views of risks from a radioactive waste repository». Risk Analysis, 13 (6), 643-648.

Frewer, L. J., Howard, C., & Shepherd, R. (1998). Understanding public attitudes to technology. Journal of Risk Research, 1, 221–235.

Goodfellow, M.J., Williams H.R., & Azapagic A. (2011). Nuclear renaissance,public perception and design criteria: An exploratory review. Energy policy 39, 6199 - 6210

Gregory, R., & Mendelsohn, R. (1993). Perceived risk, dread, and benefits. Risk Analysis, 13, 259–264.

Gregory, J., & Miller, S. (1998). Science in public: Communication, culture, and credibility. New York: Plenum.

Guo, Y., & Ren, T. (2017). When it is unfamiliar to me: Local acceptance of planned nuclear power plants in China in the post-fukushima era. Energy Policy, 100, 113-125.

Hayashi, M., & Hughes, L. (2013). The Fukushima nuclear accident and its effect on global energy security. Energy Policy, 59, 102-111.

Heffron, R. J. (2013). The application of contrast explanation to energy policy research: UK nuclear energy policy 2002–2012. Energy Policy, 55, 602-616.

Hocke, P.; Renn, O. (2009) Concerned public and the paralysis of decision-making: nuclear waste management policy in Germany, Journal of Risk Research, 12:7-8,921-940

Holt, L., Sotkiewicz, P., & Berg, S. (2010). Nuclear power expansion: Thinking about uncertainty. The Electricity Journal, 23(5), 26-33.

Horlick-Jones, T., 2003. Managing risk and contingency: interaction and accounting behaviour. Health, risk & society, 5, 221–228.

Horlick-Jones, T., 2005a. Informal logics of risk: contingency and modes of practical reasoning. Journal of risk research, 8 (3), 253–272.

Horlick-Jones, T., 2005b. On 'risk work': professional discourse, accountability and everyday action. Health, risk & society, 7 (3), 293–307.

Horlick-Jones, T., 2007. On the signature of new technologies: sociality, materiality and practical reasoning. In: R. Flynn and P. Bellaby, eds. Risk and the public acceptance of new technologies. Basingstoke: Palgrave Macmillan, 41–65.

Horlick-Jones, T. and De Marchi, B., eds., 1995. Scientific expertise in Europe. Science and public policy, 22 (3), 138–207.

Horlick-Jones, T., Walls, J., and Kitzinger, J., 2007b. Bricolage in action: learning about, making sense of, and discussing issues about genetically modified crops and food. Health, risk & society, 9 (1), 83–103

Horlick-Jones, T.; Prades, A. (2009). «On interpretative risk perception research: Some reflections on its origins; its nature; and its possible applications in risk communication practice». Health, Risk & Society [en línea], 11 (5), octubre, 409-430.

Horlick-Jones, T.; Prades, A.; Espluga, J. (2012) "Investigating the degree of 'stigma' associated with nuclear energy technologies: a cross-cultural examination of the case of fusion power". Public Understanding of Science, vol. 21, no. 5, 514-533.

Huang, L., Zhou, Y., Han, Y., Hammitt, J. K., Bi, J., & Liu, Y. (2013). Effect of the Fukushima nuclear accident on the risk perception of residents near a nuclear power plant in China. Proceedings of the National Academy of Sciences, 110(49), 19742-19747.

Hymans, J. E. (2013). The Threat of Nuclear Proliferation: Perception and Reality. Ethics & International Affairs, 27(3), 281-298.

Invernizzi, D. C., Locatelli, G., & Brookes, N. J. (2017). Managing social challenges in the nuclear decommissioning industry: a responsible approach towards better performance. International Journal of Project Management.

Irwin, A. (1995) Citizen Science: A Study of People, Expertise, and Sustainable Development, London: Routledge

Irwin, A.; Simmons, P.; Walker, G. (1999) Faulty environments and risk reasoning: the local understanding of industrial hazards. Environment and Planning A. Vol. 31 (7), pp. 1311-1326.

Jaeger, C., Renn, O., Rosa, E., and Webler, T., 2001. Risk, uncertainty and rational action. London: Earthscan

Jenkins, K.; McCauley, D.; Heffron, R.; Stephan, H.; Rehner, R. (2016) "Energy Justice: a literature review", Energy Research & Social Science, Vol 11: 174–182.

Jenkins-Smith, H.C., Silva, C.L., Nowlin, M.C. and DeLozier, G., 2011. Reversing nuclear opposition: Evolving public acceptance of a permanent nuclear waste disposal facility. Risk Analysis, 31(4), pp.629-644.

Kraft, M.E. and Clary, B.B., (1991). Citizen participation and the NIMBY syndrome: Public response to radioactive waste disposal. Western Political Quarterly, 44(2), pp.299-328.

Kasperson, R. 2014. "Four Questions for Risk Communication." Journal of Risk Research 17 (10): 1233–1239.

Keller, C., Visschers, V., & Siegrist, M. (2012). Affective imagery and acceptance of replacing nuclear power plants. Risk Analysis, 32(3), 464-477.

Kılınç, A., Boyes, E., & Stanisstreet, M. (2013). Exploring students' ideas about risks and benefits of nuclear power using risk perception theories. Journal of Science Education and Technology, 22(3), 252-266.

Kim, Y., Kim, W., & Kim, M. (2014). An international comparative analysis of public acceptance of nuclear energy. Energy Policy, 66, 475-483.

Kinsella, W.J.; Kelly, A.R.; and Autry, M.K. (2013): Risk, Regulation, and Rhetorical Boundaries: Claims and Challenges Surrounding a Purported Nuclear Renaissance, *Communication Monographs*, DOI:10.1080/03637751.2013.788253

Kinsella, W. J., Andreas, D. C., & Endres, D. (2015). Communicating nuclear power: A programmatic review. Annals of the International Communication Association, 39(1), 277-309.

Klinke, A.; Renn, O. (2002) "A new approach to risk evaluation and management: risk-based, precaution-based, and discourse-based strategies". Risk Analysis, 22 (6), 1071-1094.

Krimsky, S.; Golding, D. (eds.) Social Theories of Risk. London: Praeger

Krütli, Stauffacher, Flüeler & Scholz (2010

Kurath, M., & Gisler, P. (2009). Informing, involving or engaging? Science communication, in the ages of atom-, bio-and nanotechnology. Public Understanding of Science, 18(5), 559-573.

Lehtonen, M. (2010). Opening up or closing down radioactive waste management policy? Debates on reversibility and retrievability in Finland, France, and the United Kingdom. Risk, Hazards & Crisis in Public Policy, 1(4), 139-179.

Lehtveer, M.; Hedenus, F. (2015) Nuclear power as a climate mitigation strategy – technology and proliferation risk, Journal of Risk Research, 18:3, 273-290.

Li, N.; Brossard, D.; Anderson, A.A.; Scheufele, D.A.; Rose, K.M. (2016): How do policymakers and think tank stakeholders prioritize the risks of the nuclear fuel cycle? A semantic network analysis, Journal of Risk Research, DOI: 10.1080/13669877.2016.1223164

Lidskog, R.; Sundqvist, G. (2004) On the right track? Technology, geology and society in Swedish nuclear waste management, Journal of Risk Research, 7 (2), 251-268

Löfquist, L. (2015) After Fukushima: nuclear power and societal choice, Journal of Risk Research, 18:3, 291-303

Lupton, D., 1993. Risk as moral danger: the social and political functions of risk discourse in public health. International journal of health services, 23, 425–435.

Lupton, D. and Tulloch, J., 2002. Life would be pretty dull without risk: voluntary risk-taking and its pleasures. Health, risk & society, 4 (2), 113–124.

Mah, D. N. Y., & Hills, P. (2014). Participatory governance for energy policy-making: A case study of the UK nuclear consultation in 2007. Energy Policy, 74, 340-351.

Marris, C., Langford, I., and O'Riordan, T., 1996. Integrating sociological and psychological approaches to public perceptions of environmental risk: detailed results from a questionnaire study, CSERGE Working Paper GEC 96-07. Norwich: University of East Anglia.

Marris, C., Langford, I.H., and O'Riordan, T., 1998. A quantitative test of the cultural theory of risk perceptions: comparisons with the psychometric paradigm. Risk analysis, 18 (5), 635–648.

Maynard, D., 2003. Bad news, good news: conversational order in everyday talk and clinical settings. Chicago: University of Chicago Press.

Miller, J. D. (1998). The measurement of civic scientific literacy. Public Understanding of Science, 7, 203–223

Myers, G., 2007. Commonplaces in risk talk: face threats and forms of interaction. Journal of risk research, 10 (3), 285–305

Otway, H.; Cohen, J.J. (1975) Revealed Preferences: Comments on the Starr Benefit-Risk Relationships, Research Memorandum. Luxembourg: International Institute for Applied Systems Analysis), p. 75-80.

Otway, H.; Fischbein, M. (1976). The Determinants of Attitude Formation: An Application to Nuclear Power. Research Memorandum. Luxembourg: International Institute for Applied Systems Analysis), p. 76-80.

Otway, H.; Von Winterfeldt, D. (1982) Beyond Acceptable Risk: On the Social Acceptability of Technologies. Policy Sciences, 14, pp. 247-256.

Otway, H.; Von Winterfeldt, D. (1992) Expert Judgement in Risk Analysis and Management: Process, Context and Pitfalls. Risk Analysis 1, 12, pp. 83-93.

Palmer, S. E., & Schibeci, R. A. (2014). What conceptions of science communication are espoused by science research funding bodies? Public Understanding of Science, 23(5), 511-527.

Parkhill, K.A., Pidgeon, N.F., Henwood, K.L., Simmons, P., Venables, D., 2010. From the familiar to the extraordinary: local residents' perceptions of risk when living with nuclear power in the UK. Transactions of the Institute of British Geographers 35, 39-58.

Pidgeon, N., Slovic, P., and Kasperson, R., eds., 2003. The social amplification of risk. Cambridge: Cambridge University Press

Pidgeon, N. F., Lorenzoni, I., and Poortinga, W. (2008). Climate change or nuclear power—No thanks! A quantitative study of public perceptions and risk framing in Britain. Global Environmental Change, 18(1), 69-85.

Poortinga, W. and N.F. Pidgeon. 2003. Exploring the dimensionality of trust in risk perception. Risk Analysis 23, 5, 961-973

Poortinga, W., Pidgeon, N., Lorenzoni, I., 2006. Public perceptions of nuclear power, climate change and energy options in Britain: summary findings of a survey conducted during October and November 2005. Understanding Risk Working Paper 06-02, Norwich, Centre for Environmental Risk.

Poumadère, M. (2014) Before and After Fukushima: The Many Fronts of Managing the Nuclear Power Option. In Moor R. & Gowda R. (eds.), *India's Risks: Democratizing the Management of Threats to Environment, Health, and Values* (p. 250-274). Oxford University Press India.

Poumadère, M. (2016) Que faut-il savoir d'un accident nucléaire pour une meilleure prise en compte des conséquences sur la société ? In Merad, M., Dechy N., Dehouck, L., Lassagne, M. (dirs) *Risques majeurs, incertitudes et décisions* (p. 265-287). MA Editions – ESKA : Paris.

Prades López, A., Horlick-Jones, T., Oltra, C., and Solá, R., 2008. Lay perceptions of nuclear fusion: multiple modes of understanding. Science and public policy, 35 (2), 95–105

Prior, L., 2001. Rationing through risk assessment in clinical genetics: all categories have wheels. Sociology of health & illness, 23, 570–593

Rayner S. (1990) Risk in Cultural Perspective. In: Acting under Uncertainty: Multidisciplinary Conceptions. Theory and Decision Library (Series A: Philosophy and Methodology of the Social Sciences), vol 13. Dordrecht, Springer, pp. 161-179.

Renn, O. (1992). "Concepts of risk: A Classification". In: Krimsky, S.; Golding, D. (eds.) Social Theories of Risk. London: Praeger. P. 53-81.

Renn, O., (1999). A model for an analytic− deliberative process in risk management. Environmental Science & Technology, 33(18), pp.3049-3055.

Renn, O. (2005) Risk Governance. Towards an Integrative Approach. White Paper, 1. International Risk Governance Council (Geneva)

Renn, O. (2008). Risk governance: Coping with uncertainty in a complex world. London: Earthscan.

Renn, O. Webler, T. and Widemann, P. (eds) (1995) Fairness and Competence in Citizen Participation: Evaluating New Models for Environmental Discourse, pp. 35–86. Dordrecht: Kluwer Academic Publishers.

Renzi, B. G., Cotton, M., Napolitano, G., & Barkemeyer, R. (2017). Rebirth, devastation and sickness: Analyzing the role of metaphor in media discourses of nuclear power. Environmental Communication, 11(5), 624-640.

Rothman, S., & Lichter, S. R. (1987). Elite ideology and risk perception in nuclear energy policy. American Political Science Review, 81(2), 383-404.

Rowe, G. and Wright, G., (2001). Differences in expert and lay judgments of risk: myth or reality?. Risk Analysis, 21(2), pp.341-356.

Rowe, G., Frewer, L.J., 2005. A Typology of Public Engagement Mechanisms. Science, Technology & Human Values 30, 251-290. DOI: 10.1177/0162243904271724.

Shrader-Frechette, K., 2000. Duties to future generations, proxy consent, intra-and intergenerational equity: The case of nuclear waste. Risk analysis, 20(6), pp.771-778.

Short, J.F.; Rosa, E.A. (2004) Some principles for siting controversy decisions: lessons from the US experience with high level nuclear waste, Journal of Risk Research, 7:2, 135-152

Siegrist, M., & Visschers, V. H. (2013). Acceptance of nuclear power: The Fukushima effect. Energy Policy, 59, 112-119.

Siegrist, M., Cvetkovich, G., & Roth, C. (2000). Salient value similarity, social trust, and risk/benefit perception. Risk analysis, 20(3), 353-362.

Siegrist, M., Sütterlin, B., & Keller, C. (2014). Why have some people changed their attitudes toward nuclear power after the accident in Fukushima?. Energy Policy, 69, 356-363.

Simis, M. J., Madden, H., Cacciatore, M. A., & Yeo, S. K. (2016). The lure of rationality: Why does the deficit model persist in science communication?. Public Understanding of Science, 25(4), 400-414.

Sjöberg, L.; Drottz-Sjöberg, B.M. (2001) Fairness, risk and risk tolerance in the siting of a nuclear waste repository, Journal of Risk Research, 4:1, 75-101

Sjöberg, L., 1997. Explaining risk perception: an empirical evaluation of cultural theory. Risk, decision and policy, 2, 113–130.

Sjöberg, L. (2001). Political decisions and public risk perception. Reliability Engineering & System Safety, 72(2), 115-123.

Slovic, P. (1987) Perception of Risk. Science, 236, pp. 280-285.

Slovic, P. (1993). “Perceived risk, trust, and democracy”. Risk Analysis, 13 (6), 675-682.

Slovic, P. (2000). The perception of risk. Londron: Earthscan.

Slovic, P. and Peters, E., 1998. The importance of worldviews in risk perception. Risk decision and policy, 3 (2), 165–170

Slovic, P.; Fischhoff, B.; Lichtenstein, S. (1982) "Why Study Risk Perception?", Risk Analysis, 2 (2): 83-93.

Slovic, P.; Fischhoff, B.; Lichtenstein, S. (1984). "Behavioural Decision Theory Perspectives on Risk and Safety". Acta Psychologica, núm. 56: 183-203.

Slovic, P.; Peters, E., 2006. Risk perception and affect. Current directions in psychological science, 15(6), pp.322-325.

Stoutenborough, J. W., Sturgess, S. G., & Vedlitz, A. (2013). Knowledge, risk, and policy support: Public perceptions of nuclear power. *Energy Policy*, 62, 176-184.

Sturgis, P.; Allum, N., (2004). Science in society: re-evaluating the deficit model of public attitudes. Public Understanding of Science, 13(1), pp.55-74.

Starr, C. (1969). "Social Benefit versus Techonological Risck". Science, núm. 165: 1.232-1.238.

Tsujikawa, N., Tsuchida, S., & Shiotani, T. (2016). Changes in the factors influencing public acceptance of nuclear power generation in Japan since the 2011 Fukushima Daiichi nuclear disaster. Risk analysis, 36(1), 98-113.

Turner, G.; Wynne, B. (1992) Risk communication: a literature review and some implications for biotechnology. In: J. Durant (ed.) Biotechnology in Public. A Review of Recent Research. London: Science Museum for the European Federation of Biotechnology, pp. 109-141.

Tyler, T.R. (1994) "Psychological models of the justice motive: Antecedents of distributive and procedural justice", Journal of Personality and Social Psychology, Vol 67(5): 850-863.

Vainio, A., Paloniemi, R., & Varho, V. (2017). Weighing the Risks of Nuclear Energy and Climate Change: Trust in Different Information Sources, Perceived Risks, and Willingness to Pay for Alternatives to Nuclear Power. Risk Analysis, 37(3), 557-569.

Van der Pligt, J., Eiser, J. R., & Spears, R. (1984). Public attitudes to nuclear energy. Energy policy, 12(3), 302-305.

Van Loon, J. (2000) Virtual Risks in an Age of Cybernetic Reproduction. In: B. Adam, U. Beck, J. Van Loon (eds.) The Risk Society and Beyond. London, Sage, pp. 165-182.

Visschers, V. H., & Siegrist, M. (2012). Fair play in energy policy decisions: Procedural fairness, outcome fairness and acceptance of the decision to rebuild nuclear power plants. Energy Policy, 46, 292-300.

Visschers, V. H., & Siegrist, M. (2013). How a nuclear power plant accident influences acceptance of nuclear power: Results of a longitudinal study before and after the Fukushima disaster. Risk analysis, 33(2), 333-347.

Visschers, V. H., & Wallquist, L. (2013). Nuclear power before and after Fukushima: The relations between acceptance, ambivalence and knowledge. Journal of Environmental Psychology, 36, 77-86. Chicago

Visschers, V. H., Keller, C., & Siegrist, M. (2011). Climate change benefits and energy supply benefits as determinants of acceptance of nuclear power stations: investigating an explanatory model. Energy policy, 39(6), 3621-3629.

Visschers, V.H., Siegrist, M., 2012. Fair play in energy policy decisions: Procedural fairness, outcome fairness and acceptance of the decision to rebuild nuclear power plants. Energy Policy 46, 292-300.

Vlek, C.; Stallen, P.J. (1980) Rational and Personal Aspects of Risk. Acta Psychologica, 45, pp. 273-300.

Walker, G. (2009) “Beyond distribution and proximity: exploring the multiple spatialities of environmental justice”, Antipode, Vol 41 (4): 614–636.

Walls, J., Pidgeon, N., Weyman, A., and Horlicks-Jones, T., 2004. Critical trust: understanding lay perceptions of health and safety risk regulation. Health, risk & society, 6, 133–150

White, S., 1999. Examining the artfulness of ‘risk talk’. In: A. Jokinen, K. Juhila, and T. Pösö , (eds.) Constructing social work practice. Aldershot: Ashgate, 87–102

Whitfield, S. C., Rosa, E. A., Dan, A., & Dietz, T. (2009). The future of nuclear power: Value orientations and risk perception. Risk Analysis, 29(3), 425-437.

Whitton, J., Parry, I., Cotton, M., Konrad, W., Prades Lopez, A., Espluga, J., 2016, Theoretical, Methodological and Epistemological Challenges of the Multi–disciplinary History of Nuclear Energy and Society (HoNESt) Research Project. Paper presented at ESSHC 2016, Valencia.

Williamson, J. and Weyman, A., 2005. Review of the Public Perception of Risk, and Stakeholder Engagement HSL/2005/16. Health and Safety Laboratory, Buxton

Wynne, B. (1980). "Technology, Risk and Participation: on the Social Treatment of Uncertainty". A: Conrad, J. (ed.) Society, Technology and Risk. London, New York: Academic Press. P. 87-103.

Wynne, B. (1989). "Frameworks of Rationality in Risk Management: Towards the Testing of Naive Sociology". A: Brown, J. (comp.) Environmental Threats: Perception, Analysis and Management. London, New York: Belhaven Press. P. 33-47.

Wynne, B. (1992). "Misunderstood misunderstanding: Social Identities and Public Uptake of Science". Public Understanding of Science 3, núm. 1: 281-304.

Wynne, B. (1996) May the Sheep Safely Graze? A Reflexive View of the Expert-Lay Knowledge Divide. In: Lash, S.; Szerszynski, B.; Wynne, B. Risk, Environment and Modernity. London: Sage, pp. 44-83.

Wynne, B. (2005). Risk as globalizing 'democratic' discourse? Framing subjects and citizens. Science and Citizens: Globalization and the Challenge of Engagement. M. Leach, I. Scoones and B. Wynne. London: Zed Books.

Ylönen, M., Litmanen, T., Kojo, M., & Lindell, P. (2017). The (de) politicisation of nuclear power: The Finnish discussion after Fukushima. Public Understanding of Science, 26(3), 260-274.

Annex I: Data analysis

A.Public perception in the selected case studies

A..1. Health and Environment dimension

A.1.1. Human health concerns

A.1.2. Environmental issues

A.1.3. Safety concerns

A..2. Economic dimension

A.2.1. Job creation

A.2.2. Industrial progress and new business

A.2.3. Security of energy supply

A.2.4. Consumer economics

A.2.5. Resource requirements

A.2.6. Economic losses due to nuclear incidents

A.3. Socio-cultural dimension

A.3.1. Subjective attributes of risk

A.3.2 Social networks and identities

a) Scientific national pride

b) Land use / territorial identities

c) Socio-political identities

Cultural values, traditions and lifestyles (military imagery included)

A.4. Political-institutional dimension

A.4.1. Trust and confidence in institutions

A.4.2. Governance issues

a) Political games

b) Energy dependency

B. Public engagement in the selected case studies

B.1. Public communication

B.1.1. Restricted communication / secrecy

B.1.2. Direct actors' communication through the media and other channels

B.1.3. Visitors' information centres

B.2 Public consultation

B.2.1. Surveys and opinion polls

B.2.2. Referenda

B.3. Public participation

B.3.1. Public hearings, informative meetings and debates

B.4. Public-initiated engagement

B.4.1. Signature collection

B.4.2. Demonstrations and social mobilizations in the street

B.4.3. Media, press and written mechanisms

B.5. Other ways of influence on nuclear decision making: Legal, administrative and political routes

Under each subsection all the fragments found about these categories are commented and described, identifying of which SCRs' country and key event they come.

A.1. Health & Environment dimension

According to our theoretical framework, and after the first exploratory analysis made through the early drafts of the selected SCRs, the Health & Environment dimension includes:

- Human health: Perceptions of positive and/or negative effects related to human health (acute or chronic effects), including also perceptions of higher or lower magnitude of consequences (catastrophic potential, etc.).
- Environmental issues: Perceptions of positive and/or negative effects related to environmental issues (water, soil and atmosphere pollution, loss of biodiversity, climate change effects, etc.), including also perceptions of higher or lower magnitude of consequences (catastrophic potential, etc.).
- Safety concerns: Perceptions related to safety concerns and other control-management related factors.

A.1.1. Human health

Health concerns are mentioned in most of the Short Country Reports (SCR), although references to them are not equally distributed among historical phases.

- *Period 1950-1970*

In the period 1950-1970 references to health concerns are very scarce. The only detected mention is in the UK report (Butler & Bud 2017)), where the population seemed to be concerned about potential chronic health effects from a specific incident releasing radiation (the Windsdale fire, 1957). (Event 3, p. 35, 37)

Event 3: Windscale Fire 1957

"Some long term health impacts coming from a punctual accident raised concerns about nuclear energy among receptors (the release of some information in the 1980s, and academic articles suggesting an increase in leukaemia published in the 1990s had a longer term impact on concerns about civil nuclear energy)" (page 35).

"As little was known about safe dosage Hinton encouraged workers at Windscale to conduct tests to determine whether

> foodstuffs, and milk in particular were safe for the local populace to consume, leading to a ban on the consumption and sale of milk from the area for a month" (page 37).

- *Period 1970-1990*

Instead, during the period 1970-1990 the references to health effects increase a lot and can be found in almost all the SCRs.

The Bulgarian SCR (Hristov & Tchalakov 2017) shows nuclear power plant workers' concerns in an emergency situation (an earthquake, Event 2), which eventually caused them psychological stress, and also feelings of insecurity and helplessness (Event 3).

> *Event 2: Starting the NPP Kozloduy and the Vrancea earthquake – 1974-1977*
>
> (…) the Bulgarian delegation presented a report on the psychological stress on workers during an earthquake. This report provided suggestions on how to prepare workers, and how authorities should react in the event of an earthquake. (page 36)
>
> *Event 3: Reaction of the Green movement to the Chernobyl accident*
>
> "Over the next 2-3 years a fear was accumulated among the Bulgarian, which accelerates the degradation of the communist political system: "The lack of official announcements and explanations about the necessary radiation-prevention measures, with the circumstance, that information was irregularly provided, not sufficient, unclear, often incorrect, and manipulated in relation to the radioecology status and the radiation danger, led to oppressing uncertainty, felling of insecurity, depression, and helplessness." In this way the Bulgarian state and the communist party as its main representative, created an atmosphere of radio-phobia. In 1993 more than 38% of Bulgarian population considers radiation pollution as the most dangerous threat." (page 17).

The Finnish SCR (Michelsen & Harjula, 2017) shows how at the beginning the promoters of the nuclear program argued that radiation could be useful for medical healthy uses (Event 1).

> *Event 1: From isolation into transnational networks*
>
> "In addition, isotopes and medical use of radiation were going to cure cancer and other sicknesses and help to cultivate more productive plants for agriculture." (p.35)

In the case of the Spanish SCR (Rubio-Varas et al. 2017) several arguments related to health are found, both by citizens and by workers (firefighters, in Event 1), predominantly reflecting concerns

about potential radiation released by the NPPs. For instance, in the Showcase section the Receptors expressed their concerns about health issues saying that "our child health issues are not a game…". (Showcase, p. 25)

> *Showcase: Valdecaballeros:*
>
> "Regarding health issues, our child health issues are not a game" (p. 25)
>
> *Event 2: Ascó*
>
> "The new town hall asked the university of Bremen, Germany, for a new report in 1982 that in conclusion disapproved of the presence of the nuclear plant taking into account the radiation and health risks." *(page 37)*

In the SCR of Sweden (Kaijser 2017), after learning (from the media) what happened in international incidents like TMI or Chernobyl, the population seemed to be worried about the possibility of accidents, and influenced on receptor's argument on the use of nuclear power as well as other aspects like how to deal with the spent fuel. This seemed to increase fears and anxieties among public perceptions.

> *Event 2: TMI and the referendum on nuclear power*
>
> *"The first commission produced a report entitled Safe nuclear power? (SOU 1979:86) with an analysis of the TMI disaster, suggestions for a number of measures to increase security in Swedish reactors (for example installation of filter chambers to reduce emission of radioactive isotopes in case of a reactor melt-down) and the conclusion that a reassessment of the risks was not motivated" (page 44).*
>
> *Event 4: Chernobyl and its effects in Sweden*
>
> "Mass-media gave generous coverage to the increased radiation levels, and this caused much anxiety. Many families were afraid to let their children play outside (…)" (page 49).

The Ukrainian SCR (Kasperski 2017) includes several public concerns with respect to human health, together with public demands for compensation for families exposed to radiation. Besides, despite the serious danger, the Ukranian Public Authorities hoped that, in order to avoid more risks, the workers in charge of dealing with the Chernobyl accident could carry out their work. In this sense they recognized the damage for workers in order to achieve future safety (Showcase, Event 1).

Event 1: Chernobyl disaster (April 26, 1986)

Among the citizens rumours circulated and they complained to the government and party officials expressing the fears for their own and the **family's health** and asking for adequate protection measures and **compensation** (page 36).

Event 2: Post-Chernobyl anti-nuclear protests and vote on the moratorium on the construction of the new nuclear reactors (1989-1991)

"Ukrainian public intellectuals and scientists involved in the protests denounced the secrecy surrounding the consequences of Chernobyl during first years of the disaster and the mismanagement of radioactive fallout that they claimed criminally jeopardized the health and life of the Chernobyl victims, and they demanded extensive emergency protection measures, along with relocation and **compensation** payments". (page 42)

Event 3: Vote on the repeal of the moratorium and relatively weak anti-nuclear protests (1993-1994)

"Such anti-nuclear activist groups as Greenpeace Ukraine, Zelenyi Svit and Green Party strived to give as much publicity as possible to what they saw as unacceptable return of the Ukrainian officials to pro-nuclear positions. They considered information and outreach activities involving the general public, elected officials and expert community as one of instruments of resistance to the looming "nuclear renaissance". They reminded the public that the Chernobyl disaster and its continuing public health and environmental impacts were the tragic proofs of the inherent danger of the nuclear enterprise" (page 47)

"The local protesters in Zaporizhzhya region were primarily preoccupied by the fact that the further expansion of already vast nuclear facilities would have significant negative impacts on the local environment and people. For instance, they feared that the NPP cooling waters when allowed to flow to the Kakhovka reservoir on the Dnipro River would contaminate them with tritium and other dangerous elements. Local activists also insisted that the inhabitants of the areas surrounding the plant were poorly, if at all, **compensated** for the ever-growing risk from the nuclear site (Soiuz "Grazhdanskii dozor" 2012)." (page 48)

In the case of the USA (Josephson 2017), references to health effects are focused on the potential catastrophic impact of nuclear accidents in large populated areas (General narrative), but there are also references aimed at diminishing the importance of radiation impacts on human health (In Event 3).

General narrative:

Opponents note that nuclear power (…); may be risky, certainly more risky than supporters admit; they note that in the case of a catastrophic accident, people and property may be damaged, and timely evacuation will be nearly impossible (…). They also note the practice of siting stations near population centers may save costs for infrastructure and transmission of electricity, but opens millions of consumers precisely to the risk of accidents. (General narrative, p. 17)

Event 3 - Three Mile Island, Pennsylvania, 1979

> According to several studies, the radiation doses of the approximately 2 million people in the affected region were very small and there would be no long term health impacts. (Event 3, p. 42)

- *Period 1990-2015*

During this period the references to health effects in the SCRs tend to be lowest than before. Only the Finnish report includes a reference showing how the anti-nuclear movement put on the table the risk of a nuclear accident in a populated area as that of the capital (Event 6), and that workers and people who lived close to the nuclear power plants were in danger (Event 6), arguments that were discussed arguing that radiation is a natural phenomenon and that most of the people are exposed to natural radiation everywhere (Event 6).

> *Event 6: First nuclear debates*
>
> "That is when Heikki von Herzen stepped in. He wrote a long article in which he reflected the anti-nuclear ideas of Hannes Alfvén. IVO was making a huge mistake by investing in the fission reactors. They were old-fashioned, risky and economically infeasible. IVO's plan was especially dangerous because a 6000 MW nuclear power complex right next to Helsinki threatened the very existence of the capital. If something went wrong either in Loviisa (east of Helsinki) or in Kopparnäs, Helsinki must be evacuated. How and by whom this kind of a massive operation could be done in a hurry (Alfvén 30.8.1973)." (p.55)
>
> "Kirsti Erä-Esko challenged previous articles by taking up the moral aspects of nuclear energy and nuclear waste. She argued that small amounts of radioactivity escaped every day from the nuclear power plants and accumulated in the environment. Therefore, both workers and people who lived close to the nuclear power plants were in danger." (p. 56)
>
> "Professor Erik Spring criticized Erä-Esko's emotional interpretations. Radioactivity is a natural phenomenon and people are exposed all the time to radiation from nature. Medical profession was also continuously exposed to the radiation and x-rays were common practice in every hospital." (p. 57)

This argument is also found in the Spanish SCR, in a case of a waste repository siting (Event 5), where the Promoter (a state company) explained that the potential radiation emissions would be low and without any health risks since the radiation emitted by nature would be higher than that from the Waste Repository.

> *Event 5: Waste repository site*
>
> "A study was carried out and published with the following results: radiation emissions are low; no risk for health,

radiation emitted by nature is higher than the ones from NPP" (page 57).

A.1.2. Environmental issues

This sub-section includes perceptions of positive and/or negative effects from each country related to environmental issues, such as water, soil and atmosphere pollution, loss of biodiversity or climate change effects.

- *Period 1950-1970*

Few SCR reported environment concerns at this stage, and mostly in an ambivalent way. In the Finnish SCR environmental impacts are perceived by a fishermen community fearing that thermal pollution would damage the fragile marine ecology (Event 5, p. 48-51).

Event 5: Becoming the "Atom town"

"Fishermen were worried about thermal pollution and also possible leaks of radioactive waters into the sea." (p. 48)

"Fishermen community in near Hästholmen feared that thermal pollution would damage the fragile marine ecology of the Gulf of Finland. (p.51)

Nevertheless, in Sweden during the early years of nuclear development some social movements considered that NPPs could have positive environmental impacts (e.g. it would avoid other evident sources of river pollution) (General narrative, p. 14). No data of Promoters or Public Authorities were expressed in the SCR during this period.

General narrative

In the 1950s and 1960s, the largest and oldest environmental organization Svenska Naturskyddsförening had even demanded a faster introduction of nuclear power to save the remaining wild rivers (page 14).

- *Period 1970-1990*

Environmental concerns had a great expansion during the period 1970-1990. For instance, in Spain some Receptors (farmers and fishers) were worried about potential water contamination related to a NPP, which would negatively impact agricultural and marine activities (Event 2).

However, as a way of counter-acting these concerns, Promoters and Regulators of NPP talk about the environmental effects in a positive sense (by arguing that the NPP would increase surrounding temperature with positive effects for farming and touristic activities (Showcase).

Showcase: Valdecaballeros NPP (built but never operative reactor)

"Even the environmental impact of the NPP was suggested as an unquestionable advantage, as "heat emitted by the NPP – around 30 degrees in winter – will bring a tropical climate to the touristic destination of the Guadiana reservoirs`. This change in the climate will be to the advantage of the farmers." (Diario Ya - 25-10-1974). A report from the Ministry of Agriculture to substantiate this argument was commissioned." (page 25)

"But the real opposition to the nuclear plant arose and got organized some 80km downstream, in the city of Villanueva de la Serena, which agglutinated the landowners of the irrigated lands. Irrigators have had a precedent with an attempt to build a cellulose factory upstream, and they feared the contamination and the competition for water, "here the future of was irrigation, it was agriculture". With frequent draughts, they argued, the Guadiana river would be insufficient to meet the needs of both the nuclear power plant and the irrigated lands." (*page 25)*

Event 2: Ascó

"Later the Comitè Antinuclear d'Ascó and the CARE drew up a new document in which they expounded their opposition to use water from the Ebro river to cool the NPP reactors. It called attention to the negative consequences for the environment and the agricultural economy of the area." *(page 39)*.

In Sweden from 1972 onwards a dramatic shift took place and nuclear power was criticized from groups of scientists, politicians and environmental activists. Potential environment dangers were among the factors leading to this growing opposition (which resulted in a referendum in 1980) (General narrative, p. 13).

General narrative, p. 13

Thus, very little questioning of nuclear power occurred in Sweden until the early 1970s, but from 1972 and onwards a dramatic shift took place and nuclear power became heavily criticized by many different kinds of actors. Three of these were particularly important: scientists, politicians and environmental activists. The single person that most strongly contributed to this shift was a scientist, Hannes Alfvén. He had been awarded the Nobel Prize in physics in 1970 and thus had very high respect as researcher.

The UK report states that although Public Authorities and regulators tried to remain neutral towards nuclear power with regards to use it or not to generate electricity, there were a pressure

on the decision by the growing concerns about the environment from the Receptors side (Event 5, p. 41).

> *Event 5: Royal Commission on Environmental Pollution 1976*
>
> "Chairman of the Commission. Although a former member of UKAEA, Flowers remained neutral on whether nuclear power should be used to generate electricity. The Royal Commission on Environmental Pollution (RCEP) was in part instigated by growing concerns about the environment which had been developing in the UK throughout the mid/late 1960s" (page 41).

Environmental concerns also appeared during this period in the SCR of Ukraine, allowing a social mobilization with nationalist aims to develop following the Chernobyl accident. (Event 2, p. 39).

> *Event 2: Post-Chernobyl anti-nuclear protests and vote on the moratorium on the construction of the new nuclear reactors (1989-1991)*
>
> "The anti-Chernobyl protest became part of a broad independence movement grounded to a **large degree on environmental concerns"** (page 39).

- *Period 1990-2015*

According to the Finnish SCR, Promoters of nuclear energy claim that new reactors are necessary if Finland is going to fulfill its commitments in the global fight against climate change. Although environmentalists defined nuclear power as a non-carbon-free source of energy, the Finnish authorities reserved to nuclear energy a key role in the battle against climate change by arguing that without nuclear power stations the international climate agreement cannot be fulfilled. (General narrative, p. 25-26; Showcase, p. 30).

> *General Narrative*
>
> "Proponents of nuclear energy claim that new reactors are necessary if Finland is going to fulfill its commitments in the global fight against climate change." (page16)
>
> "Without nuclear energy Finland was forced to invest in conventional energy, and this decision defied the international agreements against the climate change." (page 25)
>
> "Only years after the Parliament handed down the negative decision. The Ministry of Trade and Industry started to prepare a new energy strategy. The guiding principle was written in the following way: "All environmentally friendly and sustainable energy production technologies should be included in the strategy". This sentence signaled to nuclear

energy companies that the Finnish government was supporting nuclear energy. Although environmentalists had previously defined nuclear power as a non-carbon-free source of energy, the Finnish authorities believed that it could be used in the battle against climate change (Litmanen 2004)." (p.25-26)

Showcase - Collective memory and the uneasy nuclear collaboration between Finland and Russia/Soviet Union
"Nuclear energy is almost emission-free, but it is not considered to be one of the renewable energy sources because it is burning uranium and other radioactive materials. They are currently not recyclable. However, nuclear energy has been regarded as one of the most important source of energy in the battle against climate change. It is argued that without nuclear power stations the international climate agreement cannot be fulfilled." (p.30)

In the Swedish report, when talking about a competition between several cities for getting a repository (Event 5), environmental risks became the dominant argument among Promoters and Receptors. Promoters explicitly focused on geology as key criteria for minimising environmental risks, but considered also other factors like the attitude of the local population and the availability of suitable transport to the area.

Event 5: A competition for getting a repository
"(…) but in Storuman and Malå the environmental dangers with a repository became the dominant argument (page 54).
"Other factors, like the attitude of the local population and the availability of suitable transport and other infrastructural facilities, were as important as geology" (page 53).

The UK SCR includes several statements explaining how the political system in the UK had been mainly supportive of NPP, and in recent years one of the arguments in justifying its favourable position was the growing importance of tackling climate change (General narrative, p. 30). In this sense, the Public Authorities (regulators, etc.) stressed the potentially positive environmental impact of the NPP. Promoters and some prominent persons in the public debate expressed the same positive views. Governments of all parties have remained supporters of nuclear power throughout the period, among the regulators' and promoters side. However, environmental concerns were detected among some Receptors who saw little progress in the solution of nuclear waste management, while other Receptors seemed to agree with a 'reluctant acceptance' (in terms of Bickerstaff et al. 2008) of nuclear power because it could help in advancing towards a low-carbon energy system and coping with the climate change challenges. (Event 7, p. 49, 51).

General narrative

"At first the Labour governments of 1997-2010 avoided taking any decision on nuclear power (or nuclear weapons).(Adams and Eaglesham, 2005) The early 2000s, however witnessed a conjunction of the depletion of North Sea gas reserves from 2005 (changing Britain from a net energy exporter to an energy importer), a capacity crisis (caused by ageing plant) and the growing importance of climate change mitigation" (page 30)

Event 7: Government repositioning on new build NPPs 2006

"The 2006 Energy Review announced that 'nuclear has a role to play in the future UK generating mix alongside other low carbon generation options', but did not cite any details of the public consultations undertaken" (page 49).

"Overall, public responses highlighted the impact of climate change on their willingness to accept the need for nuclear power. The privatised industry's efforts to portray nuclear as a low carbon technology seem to have worked, and most UK citizens believe that nuclear will have a significant part to play in the generation of electricity in the future.(European Commission, 2007) A number of high profile environmental writers and campaigners have changed their minds and now support nuclear power as part of the answer to the challenges posed by climate change.(Monbiot, 2011) As climate change continues to rate as a matter of concern for the public, nuclear power is perhaps seen as a 'necessary evil'.(European Commission, 2007) Although this is defined as 'resigned acceptance' by the report's authors 'reluctant acceptance' would be the more usual term." (page 51).

According to the USA SCR, supporters of nuclear energy emphasize the facts that nuclear power does not produce greenhouse gases that contribute to global warming. In this sense, the will of extending NPP licenses is presented as a way to slow global warming (Event 1). As a result, Congress passed the Energy Policy Act of 2005, which is offered extensive subsidies for nuclear power and other alternatives to fossil fuels. However, a sector of the Receptors finds that nuclear technology leads to the disruption of nature, and data about environmental impacts are mentioned (i.e. the heated effluent water damage fishes and other aquatic organisms). (General narrative, p. 17).

General narrative:

" (…) supporters of nuclear energy emphasize the facts that nuclear power (…) does not produce greenhouse gases that contribute to global warming; is a proven technology whose next generation of reactors are, or will be almost inherently safe". (General narrative, p. 17)

"An opposing position finds that nuclear technology leads to the destruction or disruption of nature." (General narrative, p. 17)

Showcase - Early Demonstration Projects

"Finally, the heated effluent water – up to 2.5 billion gallons a day – kills about 1 billion fish and other aquatic organisms a year." (Showcase, p. 25)

Event 1 - Licensing and Operation of Enrico Fermi (Detroit) Breeder Reactor

"Indeed, in December 2016 two US Senators called for consideration of ways to extend licenses within safety parameters to permit operation to 60 and up to 80 years as a way to slow global warming. (Lamar Alexander, Sheldon Whitehouse, 2016)." (Event 1, p. 28)

Appendix 1 – Current Status and Plans: Nuclear power in the US

"In the mid-2000s, as worries about global warming and greenhouse gases associated with fossil fuels grew, representatives of the nuclear industry began to push again to create broad government, utility, and public support for the bringing on line of a new generation of nuclear power stations. As a result, Congress passed the Energy Policy Act of 2005, which is offered extensive subsidies for nuclear power and other alternatives to fossil fuels. It offered billions of dollars in tax credits, loan guarantees for advanced nuclear reactors or other emission-free technologies up to 80% of the project cost, $2 billion in insurance to cover licensing delays to the industry, extension for 20 years of the Price Anderson Act for nuclear liability protection, and support for advanced nuclear technology." (Appendix 1, p. 69)

"Beyond costs and delays, many people oppose nuclear technology, not only because of the Fukushima disaster in March 2011, but because of fear of terrorism, on top of which gas and oil processes have dropped precipitously. Perhaps the major argument for nuclear power in 2016, then, is the argument that nuclear power does not produce greenhouse gases." (Appendix 1, p. 71)

A.1.3. Safety concerns

Perceptions related to safety concerns and other (technical) control management factors are analysed in this sub-section. These factors are also related to health and environmental issues (described above), but here we will mainly focus on its safety design and management dimensions.

- *Period 1950-1970*

Although few excerpts are found in the SCR in this period, the Finnish SCR includes several safety concerns related statements. For example, when trying to build a NPP in Finland they realize that the safety culture of the Soviet Union was considered as less exigent than the Western one (Event 4). But as the Soviet Union only delivered the technology and it was the official Finish company whose responsibility was to design and manage the project, then it became possible to add safety elements and safer designs.

Event 4: Surprise in Moscow

"IVO engineers had already visited the nuclear power stations in Obninsk and Novo Voronesh. Both experiences were far from satisfactory. The safety culture in the Soviet nuclear power stations was poor and the Soviet reactors were big and clumsy if compared to the high technology products in the West." (page 43)

"The first meeting set the tone for the summit. Soviet experts saw no need to improve the security of the reactors. Soviet nuclear technology represented the highest technological and scientific level in the world and the Soviet Union had long experience in nuclear technologies. Soviet scientists had calculated that a catastrophic accident in a nuclear power station was beyond statistical probability." (page 43)

"Soviet Union were planning a mass production of nuclear power reactors and unnecessary safety measures would make the reactors too expensive." (page 44)

"The second document revealed that in fact the Soviet Union only delivered the reactors and turbines and it was IVO whose responsibility was to design and manage the project. This way it became possible to add safety elements, steel containment and computer based instrumentation (Särkikoski 2011)." (page 46)

In Sweden, no safety concerns were raised in the early years of the nuclear program, during the time for the coordinated military-civilian research in 1945-1955, but this changed in the 1960s when, on the basis of doubts about safety issues, some technical experts and politicians criticized the program (General narrative). Criticisms both from technical experts and politicians (as regulators and promoters) about safety requirements of the reactors arose.

General Narrative

"The military and some scientists (primarily physicists and chemists) were the first to act: for the military, it was naturally of vital importance to get information about this new, extremely powerful weapon and its implications for future warfare" (page 6)

In the late 1960s he did much of his research in California and came in contact with the growing number of American scientists and engineers who began to question the safety of nuclear power plants, the difficulties of taking care of the radioactive waste from reactors, and the risk of proliferation of nuclear weapons materials (page 14).

- *Period 1970-1990*

During this period safety concerns arose everywhere, which would reveal a new public perception of nuclear developments.

According to the Bulgarian SCR, in response to the 1977 earthquake, the Bulgarian authorities (as regulators/promoters) postponed the launch of the two additional reactor blocks and

demanded additional safety measures, and later, Western specialists advocated similar measures (Event 2).

Event 2::Starting the NPP Kozloduy and the Vrancea earthquake – 1974-1977

"Despite significant improvements, the Kozloduy NPP was perceived by nuclear specialists in the West to continue to work with one constructive flaw in Western eyes: They lacked the additional concrete containment of Western nuclear plants" (page 37).

In the Finish SCR, new reactors to be built were considered by the nuclear Promoters and Regulators far safest than those of TMI or Chernobyl (General narrative).

General Narrative

"Also it has been argued that new reactors are safe and they can improve the energy independency." (page16)

"Two major accidents changed the future of nuclear energy for good. The meltdown of the light water reactor in Three Mile Island nuclear power station demonstrated how difficult it was to predict catastrophic accidents in the complex systems. Seven years later the explosion in the RBMK reactor in Chernobyl demonstrated how the lack of governance and mismanagement caused a catastrophic accident at the nuclear power station. In Finland, both accidents were studied carefully and the conclusion was that neither Three Mile Island nor Chernobyl accident could happen here (Michelsen, Särkikoski 2005)." (page 24)

In the F.R. Germany, Public authorities tried to present nuclear power as a clean and safe energy source that was not involved in any threats for the public (Event 3), and they maintained this image at least until the Chernobyl case. Meanwhile, some Receptors showed concerns about the location of the nuclear installation because of safety issues (Showcase).

Showcase: Scientific-technical institute for reactor construction (WTBR) and research centre for limnology.

The pilot-scale project SNR 300 motivated promoters due to the limited uranium reserves and regulators hoped for an efficient utilization of the minerals by building this reactor. However very soon, **the search for a site raised concerns** among receptors who demonstrated against the project, some of the demonstrators even came from the Netherlands as the chosen site was close to the country (page 19).

Event 3: Wackersdorf (planned but never built reprocessing plant)

"Up until Chernobyl they kept proclaiming publicly that **hazards will not be expected** neither from the reprocessing plant nor from any other nuclear power plant" (page 28).

In the Spanish SCR, the Promoters insisted on the safety of a NPP installation (Showcase), arguing that the technology was safe and effective. In the case of Event 1 (Vandellós I incident), the Promoters claimed that a major catastrophe did not happen due to the measures they took during the incident, demonstrating the effectiveness of the high safety standards applied. However, other Public Authorities (regional and local governments) and local social movements in the area of the NPP expressed worries about safety, especially regarding emergency measures (Showcase, Event 2). In addition, international nuclear accidents, such as TMI and Chernobyl, reinforced the claim for safety among the Receptors (Event 3).

General narrative

"While local authorities may accept the plants on the prospects of the economic bonus they promised, in many occasions the hinterland further away raised opposition due to the conflicting use of the territory and safety concerns" (page 18).

Showcase: Valdecaballeros NPP

"Promoters also insisted on the safety of the installation" (page 27)

Event 2: Ascó Nuclear Power Plant

"In 2014, and apart from safety "which must prevail over everything else", the mayor valued the impact on the area of the NPPs as being positive (…)" (page 41)

Event 3: Basque antinuclear movement

"Moreover, the clandestine sabotage of the works of the plant proliferated, casting serious doubt on the safety of ever operating the plant." (page 46)

Regarding the impact of Chernobyl on Swedish public opinion, the SCR shows that some Receptors in favour of nuclear power argued that the technology used in Sweden was very different and safer than the one used in Chernobyl and, therefore, there was no need to revise Swedish nuclear policy (Event 4). Independent experts expressed concerns about the suitability of a nuclear waste repository (Event 3). The issue of the suitability of sitting of repositories not only raised concerns at local level but also mobilise different type of actors all around Sweden,

like independent specialists willing to collaborate in analysing if the proposed place was even suitable at geological level.

General narrative

Thus, very little questioning of nuclear power occurred in Sweden until the early 1970s, but from 1972 and onwards a dramatic shift took place and nuclear power was heavily criticized from many different kinds of actors among receptors mainly. Three of these were particularly important: scientists, politicians and environmental activists (page 15).

Event 3: Local protests against a repository

At one occasion a local resistance group (in Klipperås) demanded that independent geologists should be allowed to make an analysis of the drilling materials. When this was rejected activists dressed as Santa Claus were able to steal 40 meter of drilling cores, and the independent geologists analyzing this material came to the conclusion that the local rock had vast deformation zones making it unsuitable for a repository (page 46).

Event 4: Chernobyl and its effects in Sweden

"The proponents, including scientists, industrialists and trade unionists, claimed that Swedish reactors were fundamentally different from Soviet reactors, and that a disaster like the one in Chernobyl was impossible in Sweden" (page 50).

The issue of safety was dominant in the UK public debate, and public Authorities made decisions based on the assumption that British citizens required confidence that their government had chosen the safest available nuclear technology, which, according to its safety standards, turned out to be British nuclear technology (General narrative, Events 4 and 5). They felt that this was the minimum requirement to have certain success in the deployment of the British nuclear program. Regulators reacted to concerns on the safety conditions by providing more scientific evidences to ensure a reactor was safe to operate, as receptors were concerned on the material used and related safety conditions for the operation. Also the UK SCR mentioned about scientists concerned about the safety of steel pressure vessels in the American technology and promoted instead the British one.

General narrative

"Cabinet concluded that public confidence in the nuclear programme necessitated the choice of the safest possible reactor (even if it wasn't the cheapest) and supported the construction of SGHWRs.(Cabinet Conclusions, 1974) This event shows how the balance of this decision rested on the construction of an 'imagined public' by Ministers who

valued safety over cost." (page 28)

Event 4: SGHWR chosen as AGR replacement 1974

"For the majority of press reportage, the choice was between British technology and American technology: Publicly criticised UK reactor choices at Select Committee hearings, and used the press to promote the PWR (page 39).

"Ministers, UKAEA, and notably Government Chief Scientific Adviser Sir Alan Cottrell were concerned about the safety of steel pressure vessels in PWRs." (page 40).

Event 5: Royal Commission on Environmental Pollution 1976

"Raised concerns about the 'plutonium economy' and the safety of nuclear power. Criticised the UKAEA's failure to provide a solution for nuclear waste, and (then current) methods of at-sea-disposal". (page 41)

Ukraine:

Showcase: Dealing with Chernobyl disaster aftermath

"Soviet authorities also ordered the construction of the Shelter Object (in Ukrainian, Ob'ekt "Ukrittia," but popularly known as the "Sarcophagus") to cover the open reactor building of unit 4 as quickly as possible to limit radioactive contamination from spreading further." (page 24)

Event 1: Chernobyl disaster (April 26, 1986)

"This secrecy resulted in insufficient and inadequate measures of protection for the nearby population and emergency workers sent to do the clean-up of the accident site and the villages in its vicinity." (page 34).

In the USA SCR anti-nuclear groups (as such as Friends of the Earth, Critical Mass, UCS) raised public awareness of safety issues during this period (General narrative, p. 18). In the Showcase section an incident at a NPP where the emergency procedure was not followed by those involved when reporting the fire is described, evidencing that certain organizational safety deficits had happened (Showcase p. 27). Other cases as deficits in seismic design on NPP siting or concerns about potential theft and sabotages are described (Event 2). One of the main safety related concerns in the USA is the Three Mile Island (TMI) accident, which revealed weaknesses in NRC regulatory powers and supervision, and the weak safety culture among industry and operators, and the slow response of federal and state agencies to safety issues (Event 3). This case led to

increased regulatory powers and a renewed safety philosophy among NRC staff and administrators (Event 3, p. 37).

> Such anti-nuclear groups raised public awareness of safety issues at the time: Friends of the Earth, Critical Mass, and the UCS. (Gamson, Modigliani. 1989)
>
> (General narrative, p. 18)
>
> The Emergency Procedure was not followed by those involved when reporting the fire. The construction workers first attempted to extinguish the fire, whereas the procedure specifies that the fire alarm be sounded first. The guard reporting the fire telephoned the shift engineer's office rather than calling either of the numbers listed in the procedure."(Comey, 1976) The use of polyurethane foams to plug leaks and polyvinyl chloride cable was a mistake in itself because the nature of the material. Also, the "lack of qualified, experienced, fire protection staffing contributed to the conditions which resulted in a direct loss of $10 million and an indirect loss of $30 million related to business interruption." "Poor design, fire detection and fire suppression provided only on a partial or limited basis; use of polyurethane; no management interest in fire safety" all nearly led to a meltdown.(Pryor, 1977)
>
> (Showcase p. 27)
>
> According to a U. S. Geological Survey report, the station's seismic design could not withstand the maximum potential quake possible, and this led to retrofitting and upgrading. The NRC licensed the facility after redesign.(Sneed)
>
> (Event 2, p. 34)
>
> Abalone Alliance members worried about (…) the dangers of theft and sabotage, and the short and long terms dangers of NPP.(Direct Action, 1981)
>
> (Event 2, p. 35)
>
> The Three Mile Island (TMI) accident was a partial nuclear meltdown on March 28, 1979, in reactor unit 2 near Harrisburg, Pennsylvania, and the most significant accident in US history. The accident revealed weaknesses in NRC regulatory powers and supervision, slow response of federal and state agencies to safety issues, and lack of understanding and trust among the public. After the accident, a commission under Kemmeny, analyzed the cause of the accident and response of station personnel, state and national officials, and the role of the NRC, especially its poor oversight, and the weak safety culture among industry and operators. The Kemmeny Report led to increased regulatory powers and a renewed safety philosophy among NRC staff and administrators.
>
> (Event 3, p. 37)

- *Period 1990-2015*

According to the Bulgarian SCR, during negotiations with EU for decommissioning several Kozloduy NPP reactors, the Bulgarian specialists and experts (Promoters and Regulators) had

different opinion and defended its technical and safety characteristics (Event 4). Promoters and Regulators expressed their satisfaction with the technical safety issues, in contrast with the opinion of international agencies. On the contrary, during the process of proposing building a new NPP in Bulgaria, a public committee (Receptors) aimed to engage the public with the problem of the safety conditions of the already existing NPP (Event 5).

> *Event 4: Initial negotiations and contract with the European Union for memberships, which included decommissioning of reactor bodies 1,2,3,4 at Kozloduy NPP – 1993- 2004*
>
> "Bulgarian specialists and experts had different opinion and defended the technical **and safety characteristics of the reactor"** (page 39).
>
> *Event 5: Referendum for constructing new atomic power plant in Bulgaria- 2013*
>
> "The **safety condition** of the Bulgarian current reactors was at first discussed by a group of professors also searching for firms for a national referendum. (…) This committee aimed to engage the public with the problem of the **safety condition of the first four reactors** and to renegotiate their fate" (page 43).

In Finland, rigorous testing of materials and processes and safety rules imposed by authorities are presented (by Promoters and Regulators) as guaranties of safety. (Event 6, p. 56).

> *Event 6: First nuclear debates*
>
> "Heikki von Hertzen's provocative actions started a nuclear debate that heated up in the summer of 1973. Bjarne Regnell and Björn Wahlström from IVO responded to the criticism by pointing out that there was no scientific evidence to support von Hertzen's claims. Nuclear technology was based on the systematic scientific research and rigorous testing of materials and processes. No nuclear facility was allowed to be built or operated without special permissions from the radiation safety authorities. IVO had followed every norm and rule set by the Finnish and international authorities. Safety culture was a holistic approach and it was constantly upgraded." (page56)

In Sweden, Promoters of a nuclear waste repository gave assurances that they had the appropriate technology to build a safe repository, and that the country had appropriate geological areas to do it (Event 5). Due to past reactions on the suitability of places to host repositories, the Regulators changed their strategy by a more engagement oriented strategy with local municipalities that were willing to host the facility.

Event 5: A competition for getting a repository

"In the beginning of the 1990s, SKB made a reorientation of its strategy. Previously it had tried to find sites with solid rocks without any cracks, through which water might reach to the surface. But based on more developed safety analyses SKB now started to underline that the rock itself was not single most important barrier but that the other components in a repository, the copper canister surrounded by bentonite clay, also were crucial parts of a multiple barrier system. This reorientation meant that it was no longer necessary to search for the best possible geological location in the whole country, but that the geology in large parts of the country was sufficiently good" (page 53).

In Ukraine, nuclear promoters supported by international audience elaborated a new discourse on nuclear power insisting on the safety of the new reactors opposed to the Chernobyl ones, emphasizing very important differences between the two types. The Promoters said that the new reactor models are very different from the Chernobyl type, and therefore safer (Event 3). However, Receivers do not agree very much, thinking that they were still far away from Western European standards (Event 4).

Event 3: Vote on the repeal of the moratorium and relatively weak anti-nuclear protests (1993-1994)

"In October 1993 the Parliament voted to overturn a 1990 moratorium on construction of new reactors and to keep Chernobyl open in order to address projected power shortages for the winter of that year " (page 45).

"Environmental activists also pointed out that new reactors would mean additional large amounts of spent nuclear fuel and radioactive waste, and that the problem of their safe storage and disposal was not solved in a satisfying way nowhere in the world, and completely ignored in Ukraine (Tsvetkova, 2016)." (page 47).

Event 4: Controversial negotiations on the closure of the Chernobyl NPP and public hearings on the completion of the Kmelnitsky 2-Rivne 4 nuclear reactors in exchange (1994-2000)

"Activists pointed out that Soviet-designed reactors at K2-R4 were far below Western safety standards." (page 51).

In the USA SCR a series of incidents indicates the challenges faced in mastering nuclear technology, assuring the public about safety, and the risks that are reveal in station operation that may begin from the mundane and move quickly to the near catastrophe (Showcase, p. 25). A weak safety design is reported also at the Seabrook nuclear power plant that might cause the degradation of some of the installations. It is said also that the regulator (NRC) put the station under special oversight until the problem was resolved (Event 5, p. 48). Another NPP (the Davis-

Besse NPP) has been described as, in comparison with other NPPs, a poor operating record having several serious problems during its operating life, to the point that NRC engineers have calculated a minor earthquake or accident could cause the shield building to collapse onto the reactor releasing catastrophic radiation (Event 5, p. 49-52).

> The significant number of serious accidents and "contentions" led an NGO dedicated to the health and safety of the Hudson River, Riverkeeper, to push to shut down Indian Point NPP. Riverkeeper offered ten reasons to close Indian Point including seismic risks, exemptions for safety rules, a weak evacuation plan, a threat to NYC's water supply. A series of incidents – and major accidents – indicates the challenges faced in mastering nuclear technology, assuring the public about safety, and the risks that are reveal in station operation that may begin from the mundane and move quickly to the near catastrophe.
> (Showcase, p. 25)
>
> In 2009, NextEra Energy Seabrook noted the intrusion of moisture into sections of walls in certain below-grade structures at the Seabrook nuclear power plant that might cause the degradation of some of the concrete as evidenced by pattern cracking. The NRC put the station under special oversight for 3 years until the problem was resolved.(US NRC, 2016c)
> (Event 5, p. 48)
>
> The Davis-Besse NPP has, in comparison with other NPPs, a very poor operating record. (Wasserman, 2015) In 1977 a stuck relief valve was a "precursor accident" to the 1979 Three Mile Island meltdown. In 1985 a LOCA, the worst since Three Mile Island, closed Davis-Besse for a year. In 1998 a tornado caused a total loss of power, destroying the plant's warning, communication and emergency systems, threatening a meltdown. And in 2002, the operating neglected maintenance and upkeep that allowed leaking borated water to ate a 7" hole in the reactor's pressure vessel lid, leaving only a 3/16" liner to contain the coolant and prevent a meltdown.(US NRC, 2008) The plant closed for two years costing ratepayers $600 million and resulted in a $33.5 million fine, the largest in NRC history. In 2010, the utility discovered it had to replace the vessel head again.
> (Event 5, p. 49)
>
> How safe is the station today? To replace aging, deteriorating, damaged parts, the operator made four unprecedented large cuts through the Davis-Besse concrete shield building that prevents release of lethal radiation. In 2011 a series of cracks and concrete voids were discovered, the cause of which is unknown. NRC engineers have calculated a minor earthquake or accident could cause the shield building to collapse onto the reactor releasing catastrophic radiation
> (Event 5, p. 52)
>
> To date, no comprehensive action has been taken to solve the problem of the accumulation of radioactive waste and spent fuel at power stations around the country, the latter amount which has reach 70,000 tons stored in basins or in dry cask storage at the power stations themselves and may be at risk, according to the US Academy of Sciences, from

terrorist attack.
(Appendix 4, p. 78)

According to the National Academy of Sciences, spent nuclear fuel stored in pools at some of the nation's commercial nuclear reactors may be at risk from terrorist attacks. The Board on Radioactive Waste Management issued a report that calls on the NRC to conduct additional analyses to obtain a better understanding of potential risks and to ensure that power-plant operators take prompt and effective measures to reduce the possible consequences of such attacks. Because potential threats may differ according to a specific plant's design, the committee recommended that plant-by-plant vulnerability analyses be performed.
(Appendix 4, p. 80-81)

A.2. Economic dimension

This dimension refers to the perception of factors related to economic issues, both in positive and/or negative ways. After conducting an in-depth inductive analysis, it addresses topics such as:

- Job creation.
- Industrial progress and new business related with the construction or managing of the nuclear sector.
- Security of energy supply.
- Consumer economics (concerns about energy prices, etc.).
- Resource requirements.
- Potential economic losses due to nuclear incidents.

A.2.1. Job creation

Under this sub-section, perceived issues of potential and/or actual job creation are analysed. Although it is expected to be an important factor in modulating public responses, it appears few times in the SCRs.

- *Period 1950-1970*

In early times, only the Fininsh SCR remarks that bringing employment to rural areas was one of the arguments used by promoters and regulators when searching for a place to build a new nuclear power plant (Event 5).

> *Event 5: Becoming the "Atom town"*
> The town itself was a small bilingual coastal town whose best days were in the past when fishing and agriculture gave employment and welfare to approximately 15.000 inhabitants. Now the times had changed and Loviisa was suffering from unemployment and loss of industrial enterprises. This development had sent young people and educated middle-class professionals out of town to search for a better future. K.G. Wahlström wanted to reverse the tide and nothing fit better in his plans than the first nuclear power project. It was not only a major investment, but also the biggest ever industrial project in Finland. For sure, it would bring fame and fortune to Loviisa and encourage other businesses to invest in Loviisa (Björn Wahlström 25.1.2001). (p. 48)
> K.G. Wahlström did not let these problems to disrupt his mission. This was "a onetime only opportunity" that should not be missed. It was estimated that the construction work alone would bring about 1000 new jobs to town and when the

plant was operating Loviisa would get more than 400 well paid middle class residents. (p. 49)

- *Period 1970-1990*

Spanish Promoters and Public authorities tended to highlight the creation of jobs and the socioeconomic development related to the NPPs, both at local and national levels (General narrative, Showcase, Event 2). This argument was welcomed by local governments hosting the NPPs, usually located in poorly developed rural areas. The promised jobs were of two types: builders of the NPP and operators of the NPP. Other economic compensations for the municipalities were provided in the form of taxes or other municipal incomes. These factors, the economic prosperity and the employment brought by the NPP, led the Promoters and Public Authorities to expect no opposition. However, local environmental movements had a negative perception of the economic benefits that the NPP apparently provided, which they saw as conflicting with other activities in the territory (Showcase). On the other side, the end of the lifetime of the NPP created economic uncertainties in the local population. Also the stopped NPP (because of the moratorium) was perceived as economically damaging to the municipality and employment in the area (Showcase).

General Narrative

"The typical location of a nuclear power plant was a rural landscape with sufficient water to cool the reactor. Bringing thousands of jobs to rural areas was a major selling point for the nuclear . (…) Municipalities located in Zone I of the Nuclear Emergency Plans identified the consequent impact of nuclear facilities in the **socio-economic development** of towns and geographical areas where they were located. The end of the lifetime of the NPP creates **economic uncertainties** about the future benefits of hosting a nuclear site in the local population." *(page 7-8)*

Showcase: Valdecaballeros NPP (built but never operative reactor)

"During the first period, the Promoters of Valdecaballeros linked technological and **economic progress** to the nuclear power plant, both at the local and at the national level. The economic arguments justified the location chosen: a disadvantaged region which would develop thanks to nuclear energy. NPP villages' receive substantial amounts of **money** from the government, for **job** creation and other activities. Thus, it was said that thanks to the prosperity and the employment that the NPP would bring "opposition is not to be expected" (page 30).

However, local environmental movements had a **negative** perception of the economic wealth that the NPP apparently provided, which they saw as conflicting with the traditional uses of the territory (page 28).

In fact, while local authorities accepted the plan, the hinterland a little further away rose opposing the two reactors from

early on due to the conflicting use of water by downstream irrigated landowners (page 28).

With frequent droughts, they argued, the Guadiana River would be insufficient to meet the needs of both the nuclear power plant and the irrigated lands (page 26).

When the halting of the NPP became a reality, the local government was disappointed with the decision. Thus, over the years several mayors of the municipality demanded redress for the **economic damages** they had incurred due to the fact that the nuclear plant had not been built, and for the lack of alternative projects. From the local government they suggest that the Minister does not want to hand over the fields in case they could be used in the future, if Spain bet on nuclear energy again (page 29).

Event 2: Ascó Nuclear Power Plant

The press announced, on 27 February 1970, that "the new factory of Ascó" would provide 300 jobs and while it was being built even 2,000 workers would be needed (daily newspaper La Vanguardia, 27 February 1970). The reaction of the francoist town hall was one of euphoria celebrating the possibility for the population (Garcia, Reixac & Vilanov, 1980, p. 68) (page 40).

- *Period 1990-2015*

Refering to recent times, the Finnish SCR stated that nuclear energy projects were framed as a way of fighting against the unemployment crisis in the 90's. However, it is also said that the global capitalism trends moved the industrial production to other countries and the Finnish parliament decided to support more sustainable and environmental friendly energy solutions, instead of investing in nuclear power (General narrative).

General Narrative

It was in 1993, when the Finnish parliament received a new proposal. It was accompanied by heavy lobbing from the industry and labor unions. It was also expected that the Parliament would allow the new project to move forward because Finland desperately needed large scale industrial projects that could reduce the **unemployment** crises. Finland had sunk in a deep economic slump in 1991 because the Soviet Union collapsed, and the domestic financial markets were deregulated prematurely. In 1993 more than 300 000 people were listed as unemployed. The Parliament declined the nuclear power project, and for many this signaled changing attitudes towards nuclear energy and the energy policy in general. Instead of investing in nuclear power, the Finnish parliament decided to support sustainable developments and environmental friendly energy solutions. This was possible because the industrial production had suffered during the economic crises. Energy intensive industries struggled to compete in global markets, and many companies decided to close the factories in Finland and move the production to Asia. (p.24-25)

Also the Swedish SCR made references to job creation, considered as one of the main factors in the negotiations among the municipalities competing to be selected as a repository site (Event 5).

> *Event 5: A Competition for Getting a Repository:*
> Receptors from the two municipalities argued about the risks of hosting the repository and an important argument was the job creation. The job argument was important in all the four municipalities under consideration, but in Storuman and Malå the environmental dangers with a repository became the dominant argument. In the later stages of negotiations, the job argument became dominant, and two of the municipalities engaged in a contest for the repository (page 54).

A.2.2. Industrial progress and new business

Industrial progress and new business related to the construction or managing of the nuclear sector appeared in the SCR when talking about nuclear energy and societal relationships. This dimension is strongly related to the previous one (job creation), but here we focuse more on the creation of wealth and industrial technological development and modernization in general.

- *Period 1950-1970*

According to the F.R. Germany SCR, in the early years experts and public authorities considered that having a powerful nuclear industry was crucial to the country's overall economic competitiveness. Nuclear scientists advocated both early and strongly for peaceful use of atomic energy as for them a powerful nuclear industry was crucial to the overall economic competitiveness of West Germany. However, in the 1970s there was a shift of opinion towards more pessimistic views of the effects of the technology. While the regulators strongly advocated nuclear energy as a trigger for technological and industrial modernization during the 1950s and 1960s, they developed into a critic of nuclear energy in the 1970s. (General narrative, p. 12)

> *General narrative*
> "The transition from optimism to pessimism manifested in Germany's political landscape too. While the Social Democratic Party (SPD) strongly advocated nuclear energy as a trigger for technological and industrial modernization during the 1950s and 1960s, it switched sides and became a critic of nuclear energy in the 1970s." (page 12)

The Finish SCR states that nuclear developments promised better future by enhancing industrialization, urbanization and the development of modern industrial Finland (General narrative).

General Narrative:

"Nuclear energy boosted transition from the agrarian society into modern industrial society. Nuclear power stations need educated operators, systematic scientific and technological research and organized society that governs, manages and controls the nuclear industry." (page14)

"In sum, Atoms for Peace project was one of the few positive initiatives after the devastating war. It promised better future by enhancing industrialization, urbanization and the development of modern industrial Finland (Michelsen 1993)." (page18)

The USA report shows how since the 50's the Regulator (AEC) promoted nuclear power and encouraged the private sector to join in, offering funding to private companies for conducting research and development on proposed reactor designs. (General narrative, p. 7-8, Event 1, p. 29).

Throughout the demonstration program, from 1955 to 1963, the AEC offered funding to private companies for conducting research and development on proposed reactor designs; waived charges for the loan of source and special nuclear fuels for up to seven years; and provided free research and development in government laboratories for certain mutually agreeable projects.(Mazuzan, 1980: 343) This established a tradition of direct and indirect subsidies to the private sector industry that persists into the 2010s, for example through insurance.

(General narrative, p.7-8)

To encourage industry to join onto the AEC reactor push, the US Congress passed the Price-Anderson Act (1957) with a limit on liability of $560 million. The industry was required to obtain as much insurance as the private insurance pool would provide and the federal government would provide the rest of the insurance up to a maximum amount of $500 million. Since the private insurance companies were willing to put up only $65 million, a tiny sum compared to the damages that might result from a meltdown, the federal government determined to pick up the rest. Critics of the proposal pointed out that, not only would the public taxpayer be paying for private industry's insurance, but that the limit might leave thousands of victims unindemnified in case of a catastrophic accident (see Reactor Accident Safety Studies, Appendix 5 below), and the public (the US government) would be responsible for any further cleanup and other costs

(General narrative, p. 8)

In the 1950s and 1960s the regulatory process evolved under the AEC's mandate to promote nuclear power and encourage the private sector to join in.

(Event 1, p. 29)

- *Period 1970-1990*

In a country in transition from a dictatorship towards a democratic regime, as such it was Spain during the second half of the 70's, the Promoters and the Public Authorities argued that nuclear energy was necessary for the development of Spanish industry as a whole, as well as for the hosting regions (Event 3). Promoters warned of the risk of a return to underdevelopment if the nuclear path was abandoned (Event 4).

> *Event 3: Basque antinuclear movement*
>
> Promoters stated *the strengthening of the nuclear aspect in the production of electrical energy* (Basque Country). The Minister of Industry highlighted also *the crucial influence that these facilities would have on the development of the whole Spanish industry* (page 45).
>
> *Event 4: Nuclear Moratorium*
>
> The energy sector entrepreneurs' performed a campaign in favour of atomic energy, with warnings of the risk of a **return to underdevelopment** if the nuclear path was to be abandoned. According to their arguments, nuclear was the only way out of the economic crisis (in the 80's) (caused indeed by the strong dependence on petroleum) (page 50).

During this period, in the F.R Germany the interest of Promoters in nuclear development reduced once energy consumption rose slower than expected (Showcase). This showed that fluctuations in the overall economic context could influence the profitability of nuclear projects.

> *Showcase: Scientific-technical institute for reactor construction (WTBR) and research centre for limnology*
>
> "Moreover, since energy consumption had risen slower than expected, electricity suppliers were no longer interested in the commissioning of the reactor" (page 22).

- *Period 1990-2015*

Economic progress motives are argued again in Spain during this period. For instance the economic debate also appears as polarized when analysing the case of the NWR (Event 5), which the Public authorities justified on the grounds of 'economic diversification' (of a poorly developed rural area), and its stoppage was interpreted as a harm to the whole nation's economy. Besides, some local associations (Receptors) considered that the NWR would activate

the economic opportunities for the region, sharing territory with other relevant local economic driving forces such as the agri-food industry and tourism.

> *Event 5: Nuclear Waste Repository:*
>
> Public bodies mainly justify the NWR on the grounds of 'economic diversification' – as a technological centre would go together with the repository, providing other ways of living (besides the NPPs). And the National government (PP) argues that work stoppage of the NWR will cause economic damages (page 54).
>
> "The mayor of Ascó used very similar arguments to support the candidacy: economic interests and local development (page 55)
>
> The Platform against the Nuclear Repository in Cuenca (formed by 49 organizations) declared that they "reject the site because it is against their proposal for the local development based on renewable energies, sustainable tourism and high quality foodstuffs industry" (page 57).

The USA report shows how the promotion of the nuclear sector was interpreted as a strategic sector that deserves to be subsidized by the state (i.e. General narrative, Event 2).

> Throughout the demonstration program, from 1955 to 1963, the AEC offered funding to private companies for conducting research and development on proposed reactor designs; waived charges for the loan of source and special nuclear fuels for up to seven years; and provided free research and development in government laboratories for certain mutually agreeable projects.(Mazuzan, 1980: 343) This established a tradition of direct and indirect subsidies to the private sector industry that persists into the 2010s, for example through insurance.
>
> (General narrative, p.7-8)
>
> PG&E had applied for licenses to extend operating lifetime Diablo Canyon, but in 2016 agreed with the state of California to close the reactors by 2025, in spite of industry claims that the station contributes about $1 billion annually to the local economy and is safe to operate. The utility also agreed to invest in energy efficiency, renewable power and electricity storage to offset the power that will no longer be produced by the nuclear plant.
>
> (Event 2, p. 36-37)

A.2.3. Security of energy supply

Ways and arguments for ensuring energy supply are present in several SCRs. We are defining this topic as security in the amount of the energy provision and avoiding fluctuations through time.

Other closely related topic is that of national's 'energy independence', which recalls to self-sufficiency on energy generation by each country (a topic that we will see later, in the Political-institutional analytical dimensions section).

- *Period 1950-1970*

In early period this argument was well developed in the Finnish SCR, where the security of energy supply was one of the main arguments to take decisions about nuclear projects. The quick grow of the industrial sector recalls for a balance of the irregularities of the traditional production of energy, and this role could be played by the nuclear energy. It is argued that it was difficult to build a modern industrial society without secure supply or electricity and heat, and in Finland this was especially important because much of the country is located in the arctic environment. (General narrative, p. 18-20, 24).

General Narrative:

"Finnish government appointed the Energy Committee to prepare Finnish participation in the Atoms for Peace process. The committee predicted that new hydro power stations in Lapland and the reconstruction of the national grid would satisfy the need of electricity until the beginning of the 1960's. Conventional thermal power stations were needed to complement the hydro power and balanced the irregularities of the production of electricity." (page 18)

"The currency was devaluated several times during the 1950s and 1960s. Domestic energy production was able to respond to the economic growth, but not for long. The consumption of electricity had already climbed from 8,8 TWh in 1960 to almost 22 TWhs in 1970 and the prediction for the next decade showed that the growth would continue. In order to satisfy the need, Finland had two alternatives. Conventional thermal power stations could carry a bigger load or Finland could start to invest in nuclear power. The first option was technologically easier, but it would put additional stress to the trade balance that was already negative throughout the 1960s. Nuclear power stations, on the other hand, used imported fuel, but the cost of fuel was relatively low compared to the total value of production (Voimalaitoskomitea 1974). Two nuclear power projects were launched in the early 1970s." (page19)

"Finland climbed in less than two decades from the third income level to the top level in Europe. Much of this depended on energy production. It was impossible to build modern industrial society without secure supply or electricity and heat. In Finland this was especially important, because much of the country is located in the arctic environment." (page20)

"Nuclear energy did not replace any other source of energy, but it increased the total electricity production. This was needed to secure the electricity supply to industries, cities, towns, and municipalities. Finland believed in economic growth and everything possible was done to enhance industrialization and modernization of the society. This is why so many waited anxiously that four nuclear power stations would be connected to the national grid." (pages 20-21)

"When the four nuclear reactors started to supply nuclear electricity to the national grid almost simultaneously, the second oil crises was still holding back the economic growth in Finland. There was no more lack of electricity. In contrary, nuclear power reactors produced plenty of electricity that few conventional thermal power stations could be

> temporarily closed. (…)There was no evidence that the demand of energy and electricity would slow down in the future. The growth continued, and in order to satisfy the demand it was time to start building additional capacities." (page24)

- *Period 1970-1990*

The Promoters in the Spanish SCR argued with the guaranty of energy supply (Showcase), because there are so many electricity demands in the country to meet up.

> *Showcase: Valdecaballeros NPP (built but never operative reactor)*
>
> "When the moratorium becomes definitive in the 1990s, there were attempts to revive the option to reopen Valdecaballeros. Most of the communication for and against such possibility happened though the national media. The promoters insisted in the need to open Valdecaballeros to meet electricity demands in the country and to avoid the cost incurred by stopping it.." (page 32).

- *Period 1990-2015*

No news about this topic has been found in the SCRs for this period.

A.2.4. Consumer economics

Some issues related with the perception of energy prize evolution are found here.

- *Period 1950-1970*

The prize of the electricity is one of the mentioned topics in the Finnish SCR. At the beginning, the promoters and regulators promised inexpensive electricity thanks to the nuclear power. (General narrative, p. 20; Event 1, p. 35).

> *General Narrative:*
>
> "This is why so many waited anxiously that four nuclear power stations would be connected to the national grid. Almost 2000 MWs of electricity promised inexpensive electricity that was critically needed for investments in industry, infrastructure and consumption." (page 20).
>
> Event 1:
>
> "Newspapers and magazines were full of propaganda that promised inexpensive and inexhaustible source of electricity." (page 35)

- *Period 1970-1990*

In Sweden, the public controversy for deciding to maintain or not nuclear power development, some Unions argued that a shutdown could increase electricity tariffs (but other trade unionists claimed for sustainable growth and renewable energy) (Event 4, p. 50-51). After the Chernobyl accident, Regulators' argued economic reasons either to phase out or maintain the nuclear power were a controversy in the government. The new energy policy was strongly contested by leading trade unionists, which traditionally had been a strong faction within the Social Democratic Party. Some of them argued that the shutdown could increase electricity tariffs and others claimed on economic sustainable growth based on efficiency and renewable sources of energy.

> *Event 4: Chernobyl and its effects in Sweden*
>
> *"More importantly, many leading trade unionists, which traditionally had been a strong faction within the Social Democratic Party, also opposed it. They argued that a "premature phase out" – as they called it - would lead to increased electricity tariffs, which in turn would threaten jobs in industry." (page 51).*
> *"In the following year the Party experienced fairly strong internal conflicts that were referred to as the "War of the Roses" (a red rose is the symbol of the Social Democratic Party), between an economic growth oriented faction around the trade unions, and a more environmentally oriented faction around the youth´s and women´s organizations of the party." (page 50).*

Most of the actors in the UK seemed to consider that nuclear energy contributed to maintain electricity tariffs at a competitive level (General narrative, p. 7). The cost-effectiveness of nuclear power also impacts the public opinion.

> *General narrative:*
>
> "Pessimism about the cost-effectiveness of nuclear energy seems to have affected UK public opinion particularly as the AGRs continued to over-run continually extended construction time and cost estimates in the mid-1980s. (…). However, since privatisation, nuclear power stations (and particularly the AGRs) have provided 20% of British electricity requirements and do so at a cost the public view as competitive (page 7).

- *Period 1990-2015*

In Finland SCR it is also said that nuclear power stations are not the ideal types of energy sources for today's needs (it is said that post-industrial society needs flexible, sustainable energy systems that can respond quickly to the changing needs of customers) (General narrative, p. 16,

p. 26). In this periode, international prices of electricity have dropped questioning whether nuclear energy is today economically feasible (Showcase, p. 30).

General Narrative:

"Opponents of nuclear energy emphasize the structural changes in the Finnish society. Finland is no longer dependent on energy intensive industry, but the consumption of electricity is fragmented. Instead of feeding electricity to giant factories, energy companies today are serving small and midsize companies and environmentally-aware customers. Therefore, **nuclear power stations are not the ideal types of energy sources for today's needs**. Post-industrial society needs flexible, sustainable energy systems that can respond quickly to the changing needs of customers." (page16).

"Meanwhile, climate change advances rapidly, and radical actions are necessary to control rising temperature. The price of electricity has dropped, and it is questionable whether nuclear energy is economically feasible in the future." (page 26).

Showcase:

"Nuclear energy is no longer an economically superior source of energy because the price of electricity dropped down, and the energy policy in Finland and other European countries favor renewable and alternative energy sources." (page 30)

A.2.5. Resource requirements

This category refers mainly to the need of investments (economic and other resources) in nuclear programs than should be detracted from other social or industrial needs.

- *Period 1950-1970*

In the F.R. Germany, at early stages, according to the German SCR, some of the promoters were critical of nuclear power for cost reasons and because of technical uncertainties (General narrative). Once established, nuclear industry developed into the core proponent of nuclear energy and continuously attempted to enlarge nuclear markets both domestic and abroad. The key role of the State in promoting nuclear development in the FRG is clear. Since the very beginning of Germany's atomic endeavours nuclear energy was criticised by receptors in economic terms focussing overall on the high cost of nuclear waste disposals. (General narrative, p. 8)

General narrative

"Private companies have been vital in the construction of German reactors. In the foundational period of the 1950s, however, industry was hesitant to engage in the nuclear sector and it needed the state to set the scene. Once established, nuclear industry developed into the core proponent of nuclear energy and continuously attempted to enlarge nuclear markets both domestic and abroad" (page 16). However, at the beginning some of the promoters were critical with nuclear power mainly for **cost** reasons and technical uncertainties, as it was a new and unproven technology (page 8).

In Finland, when nuclear energy became a suitable way to cover the increasing energy demands, significant investments had to be made into research and education (General narrative, p. 4-5). It appeared also the need of great investments in high quality jobs in order to attract talent of those engineers studying abroad. (Event 2, p. 38).

General narrative

"Finland joined the atomic family in the middle of the 1950s when the Atoms for Peace – program was launched and the first international conferences were organized. Although Finland needed desperately new sources of energy, it was understood that atomic energy could not provide an instant solution to the demand of inexpensive energy. Before commercial power reactors could be built, **significant investments** had to be made into research and education. In addition, it was calculated that at least a decade was needed before one commercial reactor could go critical. Therefore, nuclear energy was, and it still is, regarded as one sources of energy when the energy policy decisions are made." (page 4-5)

Event 2: Finnish nuclear power project 1955-1962

"Some young scientists and engineers who got chance to visit the United States or Sweden did not want to return home. This was understandable because the standard of living in Finland was lower comparing to the living standard in Sweden and Denmark, and it is needless to mention the United States. Erkki Laurila feared that brain drain would empty his critical mass before a nuclear power project would even start. The problem was solved by offering the returning experts a steady job with a pay that was higher than for example in universities or research centers." (page 38)

The Spanish SCR shows the importance of the financial support that Spanish electric companies (Promoters) received from foreign banks since early times. In this case, the nuclear program was seen as cheaper than expected. These financial facilities were and continue to be crucial for the business decision makers in order to proceed with or cancel their nuclear projects. (General narrative, p. 13).

General narrative

Turnkey projects, offered at a price just equivalent to coal fired plants, made losing money to the reactor manufacturers for a while. But it can also be considered a private demonstration program that allowed manufactures to create enough market for latter generations of reactors. These financial facilities were in the past and continue to be crucial for the business decision makers in order to go ahead or cancel their nuclear projects (page 13).

- *Period 1970-1990*

In Bulgaria, Regulators and Promoters expressed their concern about the high cost of the nuclear program. (Event 2, p. 33).

Event 2: Starting the NPP Kozloduy and the Vrancea earthquake – 1974-1977

"Regarding nuclear power, former vice-minister of electrification Oved Tadzher remembers that his Ministry of Electrification officials were not convinced Bulgaria was ready to operate a nuclear station. According to Tadzher, these officials considered the nuclear plant too expensive and too sophisticated for Bulgaria's existing technological capabilities." (page 33)

In the F.R. Germany, one of the reasons that made regulators to do not take the project of a research institute (Showcase) was the high costs their might suppose the commissioning and the further use of complex buildings. (Showcase, p. 22)

Showcase: Scientific-technical institute for reactor construction (WTBR) and research centre for limnology.

"The price was rather low for an object that had cost multiple times that to build, but since the German government did not want to cover the cost of dismantling the nuclear facilities at Kalkar itself it agreed to the price." (page 22).

In Spain, the changing economic context in the 80's made the whole nuclear programme unaffordable, leading the Spanish Government to proclaim a moratorium. The economic costs had skyrocketed and could not be met. With the moratorium, the utilities got rid of their debts and obtained compensation for the estimated losses incurred from stopping their nuclear projects. The high potential costs (of NPP and of radioactive waste management) had to be paid for with public resources. In fact, when analysing the Spanish nuclear moratorium (Event 4), it was interpreted by most of the actors as a way of addressing the financial adjustment of the energy sector. Nuclear energy became increasingly expensive because more and more safety

requirements were demanded, and the oil crises made the construction of NPP much more expensive. In this sense, the moratorium acted as a financial rescue allowing the electric companies (Promoters) to recover their investments. This was an economic benefit for the companies, but a loss for citizens who had to pay for this with their taxes and invoices. The Regulators agree that the nuclear moratorium responded to excess of borrowing of the power companies and the banks. The government portrayed the moratorium as the necessary rationalization of the electricity sector and the only viable option to restore their wrecked finances. A financial rescue that had to be done without harming the share price on the stock market of the companies involved and seeking the complicity of the international banks to continue financing them. (Event 4, p. 50).

General narrative

The first elected Parliament in 40 years rescaled down the nuclear project in 1979. The socialist government elected 1982 faced plenty of challenges in the midst of an economic recession. After a period of consultation and negotiation with the power companies, when it became clear that the sector required rationalization, since the sheer size of the project had become unaffordable (page 18).

The private utilities contracted the credits and owned the nuclear power plants. The Spanish government however, guaranteed many of the international credits, particularly the early ones. The bulk of the credits were paid back by the utilities. Yet those pertaining to the moratorium, as in the Italian moratorium, they were securitized in bonds guaranteed by the Spanish Government, and the cost being paid on the electric tariff by consumers (page 15).

The economic and political cycle played a crucial role in slowing down and eventually paralyzing the Spanish nuclear program. The two oil crises (1974 and 1979) slowed down the economy and the expected electricity needs, but also implied the devaluation of the peseta and a period of high inflation, thus contributing to make the financial burden of the nuclear projects unbearable for the private utilities. With the moratoria, the utilities got rid of their debts and obtained compensation for the estimated losses incurred from stopping their nuclear projects (page 17).

Event 4: Nuclear Moratorium

The energy sector entrepreneurs' performed a campaign in favour of atomic energy, with warnings of the risk of a **return to underdevelopment** if the nuclear path was to be abandoned. According to their arguments, nuclear was the only way out of the economic crisis (in the 80's) (caused indeed by the strong dependence on petroleum) (page 50).

The Spanish nuclear moratorium is fully interpreted by most of the actors in terms of economic issues. Following the TMI and Harrisburg incidents, international reports were warning that nuclear power **ceased to be a cheap** source of energy once the costs of radioactive waste management and the dismantling of defunct power plants were included (page 50).

His depiction helps to understand how the major electricity companies have driven themselves into heavy

overinvestment resorting to international debt: a tiny group of people held the power over the decisions being made (page 50).

Unlike the electricity firms, the nuclear industry was never involved in the discussions with the government about their fate regarding the moratorium and looked for eventual compensation through their contracts with project owners (page 53).

The Sweden SCR shows how the economic framework of the nuclear program changed towards a scenario of rising costs and availability of different, cheaper energy sources (General narrative). In the time of the "Swedish path" promoters became more pessimistic about the future for nuclear energy (due to decreasing oil prices and increasing construction costs). The Receptors that were against the development of atomic weapons were also concerned about the high costs for their development as well as for related research; therefore they rather propose to invest instead in other human activities like development aid (Event 1). However, the Public authorities (Regulators included) argued that it would be an enormous economic loss not to use the reactors that had been built or were under construction (Event 2). They acknowledged that nuclear power had problematic aspects and should be phased out in the long run, when there were renewable energy technologies that could replace them.

General narrative

The economic prospects seemed gloomier with decreasing oil prices and increasing construction **costs** for nuclear plants (page 12).

Event 1: The atomic weapons controversy

It was co-authored by a well-known novelist and pacifist, Per Anders Fogelström, and a social democratic student leader and reservist officer, Roland Morell. They argued that Sweden should abandon the bomb and instead use the money for development aid (page 35)

Event 2: TMI and the referendum on nuclear power

Line 1 and Line 2 also acknowledged that nuclear power had problematic aspects and should be phased out in the long run, when there were renewable energy technologies that could replace them. But they argued that it would be an enormous economic loss not to use the reactors that had been built or were under construction and that this would threaten jobs and economic welfare (page 33).

According the USA SCR, substantial cost overruns characterized the building of NPP, and social movements consider nuclear projects too expensive. Some studies state that recurrent design failures and the need to build in redundancies in safety systems multiplies some nuclear projects costs. (Event 2, p. 32, 35-36, 45).

> Substantial cost overruns characterized the building of this NPP on an active earthquake fault characterized the construction phase of this reactor (…). Utility spokesmen initially estimated costs at $400 million for two units, but by 1976 the bill had risen to $1.2 billion. When unit 1 opened on May 7, 1985, and unit two on March 18, 1987, the total cost of the plant was $5.52 billion.
>
> (Event 2, p. 32)
>
> Abalone Alliance members worried about faulty and inflated projections for nuclear power, the economic catastrophe of NPPs, (…) Direct Action, 1981)
>
> (Event 2, p. 35)
>
> Such other groups as Mothers for Peace, Friends of the Earth, and Redwood Alliance also have worked to derail nuclear power as unsafe, undemocratic, and expensive. (Direct Action, 1981)
>
> (Event 2, p. 36)
>
> A RAND study estimated that construction costs of nuclear power plants would double in real dollars every six years or less because of recurrent design failures and the need to build in redundancies and other safety systems. This was surely the case with Seabrook.(Mooz, 1979; Bove, 1978: 37)
>
> (Event 4, p. 45)

- *Period 1990-2015*

According to the Finnish SCR, nuclear power stations are capital intensive and investments in nuclear energy are deducted from renewable energy sources. In fact, the recent construction of the fifth reactor has been tarnished by delays after delays, and the costs have more than doubled. (General narrative, p. 16, p. 26).

> General narrative
>
> "This solution is denounced by those who emphasize the complexity of nuclear energy. Although it is almost CO2 free, nuclear power stations are **capital intensive and investments** in nuclear energy are deducted from renewable energy sources. In addition, building new nuclear power stations and modernizing old ones delays the transformation from centralized into decentralized energy systems. (Leiserowitz 2006). History of modern Finland can be written into this framework. Finland industrialized after the war and the modern industrial society was built during the 1950s and

1960s. The development was interrupted by the oil crises in the middle of the 1970s and the industrial society never really recovered from the crises. Instead there was a slow movement towards the post-industrial society during the 1980s. Industrial and post-industrial societies were developed in parallel until 1990 when the Finnish society experienced dramatic political and economic changes. Soviet Union collapsed and Finland integrated to the European Union. During the past two decades energy intensive industries have moved to Asia and other low labor cost countries and high technology industries and service economy has taken over." (page 16)

"Both nuclear power projects have become great disappointments. The construction of the fifth reactor has been tarnished by delays after delays, and the costs have more than doubled. The reactor might go critical in 2018, but the exact date has not yet been confirmed. Fennovoima project has had equally many dramatic changes, and the final building permission is still pending in the Finnish parliament." (page.26)

In Spain, some social movements mobilized against a nuclear waste repository argue concern by high potential costs to be paid with public resources. (Event 5, p. 57).

Event 5: Nuclear Waste Repository

The Platform against the Nuclear Repository in Cuenca declared that similar experiences in other NPP areas showed that they do not generate wealth, and worried by high potential **costs** of radioactive waste management to be paid with public resources: Thus, they stated that there is no real social consensus, the transport of wastes is not safe, a nuclear waste repository would no generate long-term wealth, and natural and cultural values in the surrounding areas could be affected(tourism) (page 57).

The high costs of the nuclear program were also discussed in the UK report, with Public authorities recognizing the need for a large amount of economic resources. Regulators concluded that nuclear power might result an unattractive option due to economics. This made governments to take a decision based in a public consultation. (Event 7, p. 49).

Event 7: Government repositioning on new build NPPs 2006

"In 2003 the Department of Trade and Industry's White Paper concluded that the economics of nuclear made it 'an unattractive option for new, carbon-free generating capacity' and pledged that 'Before any decision to proceed with the building of new nuclear power stations." (page 49).

In Ukraine, the Promoters stressed the economic viability of nuclear power, requesting an end to the moratorium (Event 3). However, the environmental activism movement from the receptors

side insisted that completion of two pending reactors lacked economic efficiency as the most efficient to compensate Ukrainian energy system for the closure of the Chernobyl NPP (Event 4).

> *Event 3: Vote on the repeal of the moratorium and relatively weak anti-nuclear protests (1993-1994)*
>
> "Nuclear promoters, with the support of their foreign colleagues, regained some influence on the policy-makers and advanced a new post-Chernobyl public discourse on nuclear power. (…) They reminded the public of the economic importance and viability of nuclear power and the need to overturn the moratorium on the construction of new reactors in Ukraine." (page 47)
>
> *Event 4: Controversial negotiations on the closure of the Chernobyl NPP and public hearings on the completion of the Kmelnitsky 2-Rivne 4 nuclear reactors in exchange (1994-2000)*
>
> The NGOs protesting against the project insisted that completion of the two reactors was not economically the most efficient way to compensate Ukrainian energy system for the closure of Chernobyl (page 51).

According to the USA SCR, opponents to nuclear energy consider that nuclear power is more costly that supporters contend, and that there appears to be great support in Congress for the nuclear sector in spite of the history of cost overruns (General narrative).

> The Energy Policy Act of 2005 offered extensive subsidies for nuclear power and other alternatives to fossil fuels. It offered billions of dollars in tax credits, loan guarantees for advanced nuclear reactors or other emission-free technologies up to 80% of the project cost, $2 billion in insurance to cover licensing delays to the industry, extension for 20 years of the Price Anderson Act for nuclear liability protection, and support for advanced nuclear technology. Opponents of these costs question subsidization of such an industry in a free market economy. Yet there appears to be great support in Congress for the industry in spite of the history of cost overruns. (Alexander, Whitehouse, 2016)
>
> (General narrative, p. 10)
>
> Opponents note that nuclear power is more costly that supporters contend, indeed has a history of cost overruns
>
> (General narrative, p. 17)

A.2.6. Economic losses due to nuclear incidents

Data on this dimension appear only among those countries that had suffered nuclear incidents with radiation released to the environment.

- *Period 1950-1970*

In the UK report a case of released radiation is described (Windscale fire, Event 3), including comments on the financial damage generated to farmers and about the compensatory economic measures adopted by the government.

> *Event 3: Windscale Fire 1957*
> Affected local communities raised concerns locally at public hearings about the effects of the fallout on their livestock. Although a milk ban was in place for a month farmers were protected from **financial damage** by **compensation** by the government (page 36).

According the USA report, insurance sector was not able to cover the potential damages in case of nuclear accident, and for that reason the guarantee has to be provided by the state with public money, a trend that started in the 50's and lasts until today. (General narrative, p.8-9)

> In simple terms, Price-Anderson covered a 10-year term. All stakeholders hoped that during that ten-year period the industry would gain experience, that the problems of reactor safety would be to a great extent solved, and also that the insurance industry would develop experience on which to base a strong program of their own. Since 1957 the Act has been extended several times, most recently in the Energy Policy Act of 2005 that extended it through December 31, 2025, and offers the nuclear power industry roughly $12 billion in liability insurance protection to compensate the public in the event of a nuclear accident.
> (General narrative, p.8-9)

- *Period 1970-1990*

The case of Chernobyl is described in the Ukraine report, which caused several material and human damages (Event 1). From an economic point of view, the arguments used by actors were mainly related to compensations claimed by the affected population (Receptors) (Event 2). Other arguments coming from independent experts stated that the Public Authorities (Regulators) established an unacceptable threshold in defining the safe situation in polluted areas, avoiding paying some of that compensation, which allowed the State and the Promoters to save economic resources but threatened people's lives (Event 2).

> *Event 1: Chernobyl disaster (April 26, 1986)*
> They also made it harder for irradiated people to qualify for the status of "liquidator" or victim of the accident and to be

entitled to social and health benefits and compensations from the state (page 29).

Event 2: Post-Chernobyl anti-nuclear protests and vote on the moratorium on the construction of the new nuclear reactors (1989-1991).

As regulators, under a certain threshold, they assumed that people could continue living without any restrictions or rights to protective measures or relocation. Ukrainian (and Belarusian) scientists (others) denounced this threshold as unacceptable, because while it allowed the state and industry to save a lot of money, it threatened the health and life of the people (page 41).

The USA report includes references to the economic costs caused by the TMI accident, both in terms of total cleanup costs, as well as in terms of the increased budget devoted to regulatory activities in the aftermath (Event 3). Improved regulation would increase economic operating costs in the future.

The total costs of cleanup were $1 billion over 12 years. The accident was rated a five on the seven-point International Nuclear Event Scale as an “Accident With Wider Consequences.” (Ibid.)

(Event 3, p. 39)

Dorothy Nelkin wrote that the NRC responded to the post-TMI criticism with some energy. As a result of the accident and subsequent criticism of the NRC, its staff grew by 14 percent from 2,841 to 3,240 in one year, and its annual budget increased from $325.8 million to $423 million. Requirements were developed for additional training of reactor operators. Emergency plans include telephone hotlines to a commission emergency response center. The inspection system was improved and the structure of the commission itself reevaluated. But "improved" regulation will inevitably increase operating costs and it may also exacerbate the problems of complexity, com-pounding the difficulties of management and the risk of systemic effects.(Nelkin, 1981: 138)

(Event 3, p. 42)

- *Period 1990-2015*

None excerpt related to this period has been identified in the SCRs.

A.3. Socio-cultural dimension

The socio-cultural dimension refers to several factors identified by two different theoretical approaches: the Psychometric paradigm and the Cultural Theory of risk. It is well known that some factors can influence individual risk responses, such as unwillingness to be exposed, familiarity with the risk, the controllability of the consequences, the deferred appearance or not of damage in time or space, etc. (risk attributes in terms of Fischhoff et al., 1978; Vlek and Stallen, 1980; Slovic 1984, 1993, 2000). Besides, risk could play a role in the maintenance of a certain social order (Douglas and Wildavsky, 1982), therefore, certain groups emphasise the perception of certain risks over others generating different social identities. All these factors can be summarised as follows:

- Individual risk attributes (unwillingness to be exposed, familiarity with the risk, the controllability of the consequences, the deferred appearance or not of damage in time or space, etc.).
- Social networks and territorial identities (collective identities, conflictive land uses, etc.).
- Cultural traditions and lifestyles (social and ethical impacts, etc.).

A.3.1. Subjective attributes of risk

Here we consider the influence of perceptions of factors such as unwillingness to be exposed, familiarity with the risk, controllability of the consequences, or the deferred appearance or not of damage in time or space. The nature of the SCR makes it difficult to find information relevant to this topic, which probably would require data at a more individual and subjective level. However, some clues have been found.

- *Period 1950-1970*

In the Finnish SCR some word about the difficulty of calculating nuclear risk (and the correlative distance between experts and lay people) can be found (“engineers and scientists tend to be overly optimistic. (…) Anti-nuclear groups spread alternative truths about the nuclear risks”) (Event 5). Also the concept of ‘unwillingness’ to be exposed to risk explains some of the public

attitudes against nuclear infrastructures (from the receptors' side) (as such the case of the residents of the town of Loviisa, where a NPP was proposed) (Event 5).

> *Event 5: Becoming the "Atom town"*
>
> "The risk was a complex issue that could not be easily understood and explained. Engineers and scientists tend to be overly optimistic. The risks were there, but the probability was less than nothing. Anti-nuclear groups spread alternative truths about the nuclear risks. Nuclear technology was novel technology and nobody was able to tell for sure how the reactors behaved under heavy pressure for decades. There were also other open questions concerning nuclear waste and possible terrorist attacks against nuclear power stations. For local politicians and landowners these questions weighted heavily against the economic benefits of nuclear power." (page 46)
>
> "K.G. Wahlström had also forgotten to ask the opinion of local fishermen, farmers and summer guests. They were the core of the Swedish folk party (RKP) constituency that was the biggest political force along with the Social Democratic Party (SDP) in the bilingual town of Loviisa. Fishermen were worried about thermal pollution and also possible leaks of radioactive waters into the sea. Summer residents came mostly from the capital region and it was not in their interest to get a massive nuclear power station to spoil the beautiful sea view." (page 48)

In the UK the public perception of the controllability of the technology became a key factor in social acceptance, according to the Promoters and Regulators. In the case of Windscale fire a governmental report claimed that the cause of the incident was a "human error by well-trained but unfortunate plant staff", which inform of a weak point on the confidence granted to the controllability of the plant (Event 3).

> *Event 3: Windscale Fire 1957*
>
> William Penney conducted a review of the accident for UKAEA which was sent to Prime Minister Harold Macmillan. The report claimed that the Ministry of Defence requirement for tritium (for the H-bomb programme) had been a major cause along with defective management of the crisis by UKAEA. However, the report released by the government (some months after the fire) claimed that the cause was human error by well-trained but unfortunate plant staff. (Arnold, 1992). (page 36).

- *Period 1970-1990*

Public authorities and Receptors in the F.R. Germany perceived low controllability of the risks of the technology in the case of a Scientific-technical institute for reactor construction (WTBR) and a research centre for limnology (Showcase). The critique to the project was even greater after TMI because a reactor of this type was seen not easily to be taken under control and therefore

involved more risks. Concerning regulators, some of them considered the commissioning as irresponsible, because the risks were ultimately not calculable.

> *Showcase: Scientific-technical institute for reactor construction (WTBR) and research centre for limnology*
> "The minister of social affairs and labour of North-Rhine-Westphalia, Friedhelm Farthmann (Social Democratic Party), who was responsible for the planning permission, argued that the commissioning was irresponsible because the risks were ultimately not calculable. According to the atomic law the federal government was able to enforce the authorization, but did not want to carry the responsibility for the controversial SNR project alone. One reason for this decision was the disaster in Chernobyl that had happened in April 1986 and caused the atmosphere in West Germany to become increasingly critical of nuclear energy (Interview Avena 2016)." (page 21)

In Spanish SCR several dimensions of technological colonialism (at international level) and imposition over local society (at national level) were discussed (Showcase, Event 1). In both cases we find the notion of "unwillingness" to be exposed to a risk, one of the key factors underlying public responses. Besides, Promoters and Public Authorities expressed their views that people living near the NPP were coping with similar risks in their everyday life (such as road accidents) in order to minimize its importance (Event 1). Perception of catastrophic risk, very different from that expected by the experts, can also be detected (Event 3).

> *Showcase: Valdecaballeros NPP*
> "The rhetoric of the anti-nuclear movements include aspects identifying nuclear power with technological **colonialism** and imperialism given the crucial role played by the US on its expansion in Spain, but also by the Spanish electricity companies and the Administration that **impose** their will on the locals" (page 27).
>
> *Event 1: Vandellós I*
> "The director of Vandellós I plant in an interview asserted that "people killed in road accidents caused by tourism deserve more attention than nuclear accidents listed" (El Correo Español, 21 September 1974)." (page 36)
> "Local governments related to the fact that the population is "familiar" with the risks. This is especially so in the case of Vandellós, where in the 1980s a second reactor was installed. Apart from the familiarity, the access to information about the risk management provided by ENRESA is highly valued." (page 37)
>
> *Event 3: Basque antinuclear movement*
> "Besides, the maximum provincial institution (public authority) commissioned a report to international experts who give in part reason to antinuclear: **risk multiplied** in a densely populated area." (page 46).

- *Period 1990-2015*

In Spain some Receptors expressed beliefs about the familiarity of the local communities with the NPP because its presence became part of their daily life (as some local governments said, other nuclear facilities had been in the area), or it is considered as similar risk as any industrial facility (Event 5).

> *Event 5: Nuclear Waste Repository*
> "For the associations in favour of the ATC, the nuclear waste repository is considered a passive facility involving the **same risk** as any industrial facility." (page 55).

In Sweden 'familiarity with the technology' seems to play a role in the absence of strong opposition, according to the Promoters ("the population were already accustomed to nuclear facilities and did trust in the nuclear industry"). (Event 5).

> *Event 5: A competition for getting a repository*
> "In both the two proposed municipalities, Östhammar and Oskarshamn, the population were already **accustomed to nuclear facilities** and did trust in the nuclear industry. This implied that no strong opposition emerged." (page 54).

A.3.2. Social networks and territorial identities

The arguments and perceptions found in this section can be classified in three main categories: a) those related to national and/or scientific pride; b) those related to territorial identities; and c) those related to socio-political identities.

a) National / scientific pride

The actors tend to justify their activities and opinions by appealing to national pride or (national) scientific progress.

- *Period 1950-1970*

In the Bulgaria SCR, sometimes the actors' discourses have to do with the collective identities they seek to promote. For instance, some actors justify their support for nuclear energy because it was a symbol of scientific progress and, therefore, of national pride (Event 1). This can be understood as a collective identity that some actors would like to be shared by all national actors (mainly Promoters and Regulators). Instead, Receptors fear to be accused by future generations for their support of nuclear developments.

> *Event 1: Starting the experimental reactor IRT-2000 NEAR SOFIA IN 1962*
> "On Soviet side it was the expansion of their scientific and technological model. For Bulgaria it was announced as sign of brotherhood and big scientific step." (page 32).

The Finnish SCR insists several times in the key role played by the 'national scientific pride' in justifying the nuclear projects decisions. Nuclear program helped in establishing high quality scientific and technological research and education institutions, and allowed Finnish experts and politicians to participate in key international conferences during the Cold War. (General narrative, Events 1 and 2).

> *General narrative:*
> Secondly, in order to build and operate nuclear power stations, Finland needed to establish high quality scientific and technological research and education institutions. Helsinki University of Technology was waiting to move from the downtown campus to the Otaniemi campus, but the project had been delayed for years. Atoms for Peace initiative could be used to enhance this project, too." (pages 17-18)
>
> *Event 1: From isolation into transnational networks*
> "Eisenhower's speech was immediately registered in Finland. The largest daily newspaper, Helsingin Sanomat, praised the initiative. Scientific and engineering communities also studied the proposal with great enthusiasm. Finland had been isolated from the high technology and big science research but at that time the tide was changing. Atoms for Peace program offered a chance to conduct ambitious scientific research and to get access to classified information. (Rauhan atomi, HS 13.12.1953)." (page 34)
> "Finnish delegation was invited to participate in the First International Conference for the Peaceful Use of Atomic Energy. The conference was organized by the United Nations and held in Geneva in August 1955. Finnish delegation had six members and they were seated in French alphabetical order, right behind the United States delegation. This was a glorious moment because in front of the unknown Finnish scientists and engineers sat the scientists and engineers who had worked in the Manhattan Project. This was also the first time when Finnish scientists and engineers felt that they had equal opportunity to participate the international conference (page 35)

Event 2: Finnish nuclear power project 1955-1962

"Having established networks with Scandinavia, the United States and also the Soviet Union, Erkki Laurila felt that Finland was ready to apply membership in the International Atomic Energy Agency. The Soviet Union opposed the idea, because the political role of the IAEA was unsettled. The Soviets feared that the transnational institution would become an institution which is fully controlled by the United States. It had taken several years and negotiations before the IAEA was established. Finland was invited to be one of the 67 founding members, but the Finnish government turned down the offer. It was understood that Finland would be nothing more than one small nation among the others if she were to accept the founding member status. However, Finland would be recognized as a competitive nation if the IAEA would send a separate invitation to Finland to join the organization. This strategy worked, and Finland became the first invited nation to the IAEA in September 1958 (Fisher 1997)." (page 39)

In the UK the nuclear developments (even for military purposes) were justified by Promoters and Regulators as a matter of prestige and British supremacy in the international community. For the government, the major reasons for going ahead were prestige, and to maintain Britain's place at the 'top table' of international politics.

Event 1: First nuclear weapons test 1952

"The programme was not common knowledge in Parliament until 1948, and not common knowledge amongst the public until the first successful weapons test on 3 October 1952.(Hennessy, 2007) Government regulated the weapons programme at an executive (Ministerial) level using small Cabinet committees to manage the nascent programmes.
Even before the cold war had begun, the government sought to maintain British prestige, and Britain's place at the 'top table' of international politics through its nuclear expertise and weapons." (page 31)

In the USA report some words were devoted to the special prestige of scientists owing to their success in the Manhattan Project and in role in the unfolding Cold War military-industrial struggle with the USSR. (General narrative, p. 10)

One explanation for the strength of the industry is the special prestige of scientists owing to their success in the Manhattan Project and in role in the unfolding Cold War military-industrial struggle with the USSR. Scientists generally played a major role with little public concern about their power and influence in federal agencies in technology assessment until the 1970s.
(General narrative, p. 10)

- *Period 1970-1990*

In the F. R. Germany SCR it is said that being in support or against nuclear power is a matter of how to be seen by future generations: as a traitor or as a hero. It implies the generation of an identity shaped for the pro or anti attitude. (General narrative)

> *General narrative*
> "First, nuclear opponents feared future generations' accusations that their ancestors had failed to act against the atomic industry and had become its accomplices instead; children and grandchildren had made similar arguments regarding the country's national socialist past. Those who did not wish to be seen as traitors and followers had a duty to oppose nuclear power. Additionally, large parts of the population frequently mistrusted the state and the energy industry, and faith in the problem-solving strategies of experts and academics faded." (page 13).

According to the Swedish SCR, one of the arguments to support nuclear developments in Sweden was the importance for the country in terms of its good position in the international community. Thus in 1972 when the Swedish king inaugurated the Oskarshamn plant, he remarked on the importance of this milestone for the country in terms of technological development and the beginning of a new epoch. (General narrative)

> *General narrative*
> "On May 18, 1972 the nuclear power plant in Oskarshamn was inaugurated by the king of Sweden, Gustav VI Adolf with the following words:
> "Nuclear power is a proof of man's ability to develop his surroundings. In an ever-increasing pace it has come to stand out as the rescue out of a feared energy crisis. In a time when the epoch of hydropower development is coming to a close and difficulties are being discerned regarding the supplies of fossil fuels nuclear power has been realized. Sweden's first commercial power plant thus marks the beginning of a new epoch in our country´s energy supply. The completion of this nuclear power plant is a milestone in our country´s industrial development. Swedish industry has with foresight and skillfulness independently developed a technology of which we today can see the application. The Oskarshamn power plant represents a technical achievement which well matches the great innovations in Swedish industry." (Citation in Gimstedt 1990)
> The inauguration was a moment of great pride for all participants and the future for nuclear power looked very bright indeed. The participants made up what could be called a "nuclear-industrial complex" encompassing ASEA-Atom, Vattenfall and the private power companies, government and government agencies and technical universities. This complex planned to build 24 plants in the coming decades and the prospects for exporting nuclear technology were also promising.
> (p. 12-13)

- *Period 1990-2015*

In Spain, Promoters showed themselves proud of their knowledge and experience in decommissioning nuclear installations (Event 1). Although in this case the Promoters failed in managing the NPP (a serious incident happened in 1989 leading to the closure of the NPP), they try to present themselves as reliable managers, and the failure is presented as a learning opportunity to become better specialists. In this sense, they are proud of their good knowledge and experience in decommissioning the NPP. This argument can be considered as a matter of professional status, as a way of maintaining their place in their social networks. Besides, according to the Spanish SCR, Promoters (and some Receptors) of a nuclear waste repository (Event 5) considered that nuclear developments would lead the country to scientific excellence, allowing high level scientific jobs in the area.

Event 1: Vandellós I

"In an interview to the newspaper El Mundo (2003), the director of the decommissioning NPP highlighted the knowledge and technical experience gained at the decommissioning of Vandellós I, guarantying the high reliability and safety levels, generating international benchmarks for decommissioning nuclear power plants." (page 37).

Event 5:Radioactive waste repository

"Promoters argued that it is good for the region because hundreds of jobs will be created during the building process. It is a safe and effective technology, and, besides, the ATC will lead Spain to the scientific excellence." (page 56)

b) Land use conflicts / territorial identities

Sometimes the nuclear projects collide with other activities developed on the territory, altering the ways of living of some people in the area. It is linked to the perception of inequality, feelings of comparative grievance, and perceptions of an unequal distribution of advantages and disadvantages between territories with and without a NPP. These issues can be related to the distributional justice debate (Jenkins et al. 2016, Tyler 1994; Walker 2009), and easily become a source of conflicts with territorial and social identity frames.

- *Period 1950-1970*

In the process of finding a place for the first nuclear power plant in Finland (1966), land owners and community politicians were suspicious about the search for sitting a nuclear energy installation. Several municipalities were reluctant to the sitting decision because the project did not fit in its future development plans (Event 5).

> *Event 5: Becoming the "Atom town"*
> "Search teams were sent to the west coast of Finland where a number of promising locations were discovered. However, land owners and community politicians were suspicious about nuclear energy." (page 46)
> "IVO negotiated with all three communities, but none of them responded favorable. Hanko had free space for the nuclear power plant, but the town hesitated to make a decision. Tvärminne community was reluctant to even consider the possibility. University of Helsinki had marine biology research center in Twärminne and the community wanted to remain industry-free zone. Porkkala was interested, but the nuclear power project did not fit in the future plans of the community. Porkkala wanted to develop its unique natural environment to serve summer guests, golf players and farmers. (page 47)

In the UK Windscale event concerns about potential pollution of local food products were raised by the Receptors (Event 3). This recalls to a conflict between social and economic activities and land uses in the area where the NPP was located.

> *Event 3: Windscale Fire 1957*
>
> "Also concerns were raised about the status of **local products**, in this case milk. Affected population had concerns on the effect of the accident in local products (milk)." (page 37).

According to the USA report, the Enrico Fermi NPP licensing process may be the first time in US history that public individuals began to oppose nuclear power. It is said that the head of the United Auto Workers became convinced that the NPP would endanger Detroit, the auto industry and auto workers themselves, and brought sought against the station (Event 1). It describes a conflict between different economic activities in the same territory, by defending concrete ways of living.

> The Enrico Fermi licensing process with court intervention may be the first time in US history that public individuals began to oppose nuclear power. The head of the United Auto Workers Walter Reuther became convinced that the Enrico Fermi NPP would endanger Detroit, the auto industry and auto workers, and brought sought against the station. Leo Goodman, a union activist who had helped to organize nuclear workers, convinced Reuther to oppose the

> construction of the station. This led the UAW to bring suit to stop construction.
>
> (Event 1, p. 29)

- *Period 1970-1990*

In the F.R. Germany, the pilot-scale project SNR 300 motivated promoters due to the limited uranium reserves and regulators hoped for an efficient utilization of the minerals by building this reactor. However very soon, the search for a site raised concerns among receptors who demonstrated against the project. Many of the demonstrators even came from the Netherlands as the chosen site was close to the country's borders (Showcase). In this case land conflicts were related to political territorial borders. Also in the F.R. Germany, by locating the planned repository site in the economically underdeveloped hinterland the government tried to avoid opposition against the project, which failed because the level of protest increased. (Event 4)

> *Showcase: Scientific-technical institute for reactor construction (WTBR) and research centre for limnology*
> "Soon criticism arose about the building of the fast breeder, based on doubts about the safety of nuclear energy, and in 1974 around a thousand people, predominantly from the Netherlands, took to the streets. A mass rally three years later was attended by 40,000 people (some authors speak of 50,000 [Tompkins, Grassroot(s) 2016, 129] or even 60,000 people, [Mende 2011, 332]) from France, the Netherlands and West Berlin." (page 19)

In Finland, Event 6 reported concerns about the sitting of nuclear power plant right next to large urban areas. It was argued that six large scale reactors would need massive amounts of cooling water and fresh water and also an industrial size infrastructure, which was a great impact for a small community. Besides, it was said that "nuclear power stations would also destroy the image and identity of Kopparnäs" (Event 6). Threats to local identities were a source of public reactions against nuclear developments.

> *Event 6: First nuclear debates*
> "Kopparnäs community council could not make the decision. IVO's plan was too extensive and complex and it was impossible to estimate all the consequences. The project would multiply tax revenues, but also turn the quiet coastal community into a massive construction site that would go on for decades. Nuclear power complex would also alter the ethnic structure of the community. The dominant language in Kopparnäs was Swedish, but construction workers and nuclear operators would most likely speak only Finnish. Kopparnäs community tried to evaluate the environmental consequences of the project. If the discharge waters were directed to the district heating network, the thermal pollution

in the Gulf of Finland would cause no harm to the marine biology. However, six large scale reactors would need massive amounts of cooling water and fresh water and also an industrial size infrastructure. Nuclear power stations would also destroy the image and identity of Kopparnäs." (page 55)

"IVO's plans took nuclear power reactors right next to the large urban areas. This caused fear and anxiety. Loviisa and Olkiluoto were far away from urban centers, but Kopparnäs was less than 40 kilometer away from Helsinki. The question was how safe it was to live right next to a nuclear power station. Academician Erkki Laurila had full confidence in nuclear energy. He could very well live next to the nuclear power station, because "no technology that has been invented by man has been so thoroughly researched, tested and inspected as nuclear energy." (page 58)

In Spain, territorial/regional identities played a crucial role in accepting or rejecting nuclear projects. In some instances, when the central government or other centralised authority took the location decision, the opposition to nuclear power became a fight for regional identity vs. the central government and the economic power imposition in the territory. This happened, for instance, with the early attempts to locate the first NPPs in Spain (General narrative), or with the Valdecaballeros case (Showcase). In many cases Spanish environmental movements (receptors) denounced the unequal distribution of risk among territories, with the area treated as a landfill of dangerous and/or annoying infrastructures (Showcase, Event 2). In some way there is also a conflict between a rural world which feels forgotten and an urban world that holds the main benefits. From the Receptors opposing the NPP, it is argued that that territory concentrates already too many industrial risk facilities (petrochemical, nuclear, etc.). Other argument is that it is a rural area disadvantaged, in crisis and losing population, which instead of giving a positive development reserve a role of landfill of what favored areas do not want (perception of inequality, comparative grievance). Behind the conflict of Ascó there is a tension between a rural world which feels being forgotten and the urban world that holds the main benefits.

General narrative

Electricity utilities began to clash with **local interests** in virtually all locations chosen for their central second- and third-generation (pre-authorizations granted between 1973 and 1976). And municipalities played a decisive role in their fate. While local authorities may accept the plants on the prospects of the economic bonus they promised, in many occasions the immediate hinterland rose opposing due to the **conflicting use of the territory**. The conflict of interest was clear: tourism entrepreneurs, owners of holiday homes and the town council understood that the location chosen was placed in a territory qualified in the Urban Plan of Peñíscola approved in 1960 area, as developable area excluded from any use commercial or industrial, with the sole exception of the uses of hostelry. In many cases, the fears derived

from the alteration of land use and conflicts of interests and identities that nuclear power plants generated (page 15).

This becomes clear on the interviews with antinuclear leaders, all of which started their activity when a nuclear project was announced on their territory (village, hinterland, birth place, etc.) (page 21).

Showcase: Valdecaballeros

It became a fight of the regional identity versus the central government and the economic power (represented by the utilities) (page 20).

The regional president of Extremadura also recognized, some years later, "once we won the battle of Valdecaballeros, people began to think we [the regional government] had a heavy responsibility and great power. Valdecaballeros represents a turning point for Extremadura's autonomy. It was from that collective triumph, when we began to seriously assess the expectations that opened in our land with autonomy (page 24).

In Sweden, exploration activities looking for repository sites involved, at local level, specific protests with a NIMBY ('Not In My Backyard') emphasis from the Receptors (Event 3). This was, however, a first step towards a more general critique of nuclear developments, which included the defense of local territories.

Event 3: Local protests against a repository

"They developed a more general critique of the intended method for a repository with the aid of counter experts. Their resistance was thus not primarily of a **NIMBY** character but questioned the plans for final storage in general" (page 47).

"The local organizations first argued against a repository in their own backyard (NIMBY), but soon developed a more general critique of the intended method for a repository **with the aid of counter experts."** (page 48).

- *Period 1990-2015*

During this period in Spain new warnings on unequal distribution of risk among territories have been detected, with some areas treated as a landfill of dangerous and/or annoying infrastructures. For instance, the sitting process for a nuclear waste repository has unleashed a sharp political contest between several social movements and public administrations, with a large dose of territorial and social identities in between. (Event 5)

Event 5: Radioactive waste repository

The Platform against the Nuclear Repository in Cuenca declared that they "reject the site because it is against their proposal for the local development based on renewable energies, sustainable tourism and high quality foodstuffs

industry" (page 56).

c) Socio-political identities

This sub-section describes the actors' arguments related to political identities. In several of the analysed events, the affected population was organized into social movements that protested against a particular political regime, including nuclear power in its protests. In this sense, the public rejection was instrumental (functional) and linked to the rejection of other actors characterized by their support of nuclear developments.

- *Period 1950-1970*

The Finland SCR shows that the Finnish nuclear program played a political role in the international position of the country, located in between West and East, helping in building a Finnish identity adapted to the geopolitics of the Cold War. (General narrative, Event 1)

General Narrative:

"Nuclear power was a part, but not the most visible part of the modern industrial Finland. During the 1950s and 1960s Finland came out of the isolation and integrated to Europe without forgetting her special relations to the Soviet Union. Finland was located in between West and East and concretely on the Iron Curtain. Loviisa nuclear power plant became the symbol of this polarized situation. The reactors came from the East, but the safety and control technology was purchased from the West." (page.20)

Event 1: From isolation into transnational networks

"The Geneva conference 1955 ended a decade long isolation that had blocked Finnish scientists and engineers out of the international scientific community. The symbolic value of the conference was indispensable. The Geneva conference also relaxed political and ideological tensions and helped to establish a transnational network of scientist, engineers, corporate managers and authorities." (page 36)

According to the USA report, in Cold War times being pro or against nuclear energy was sometimes interpreted as being pro or against the national sentiments. For this reason, some cases of early protesters were qualified (and pursued) as communists. The East-West

competition at that time seemed to frame the whole nuclear debate in the USA. (General narrative, Showcase)

> The framing is directed toward a potentially confused or uneducated public, perhaps even towards those with dangerously anti-American sentiments. For example, protestors against construction of a reactor at Bodega Bay were equated by the utility PG&E with communists. (Walker, 1990) In his study of opposition to Diablo Canyon, Wills argues that antinuclear activism reflected more concerns about "about human ties with nature" than East-West competition or anger over big government. (Wills, 2006: 9).
>
> (General narrative, p. 17)
>
> As protests grew, PG&E played hardball accusing the association of being a communist front organization.
>
> (Showcase, p. 23)

- *Period 1970-1990*

In Bulgaria, during this period, the dependency on the Soviet Union's nuclear technology was presented as a symbol of brotherhood between Communist countries (Event 2).

> *Event 2: Starting the NPP Kozloduy and the Vrancea earthquake – 1974-1977*
>
> The final decision was that the team of Bulgarian specialists would do the actual work, while the Soviet team would have a controlling and observing role. It is clear that the young Bulgarian specialists had a lot of respect for their Soviet supervisors; they amply praised Soviet professionalism and said they learned very much from it (page 35). The construction and operation of this NPP was again seen by promoters (Soviet Union) as **a symbol of brotherhood between Communist countries** (page 37).

In the case of Spain, many of the anti-nuclear movements are difficult to distinguish from the anti-dictatorship movements (Event 2). The fact that the nuclear developments took place during the dictatorship linked symbolically this technology to this political regime. Additionally, the nuclear debate polarized the interrelationships between the actors in the Basque region, where a terrorist group (ETA) made anti-nuclear speech one of their hallmarks (even having been pronuclear in the past, as a way of instrumentalizing the growing public opposition to the NPP sitting processes) (Event 3).

> *General narrative*

"Many of these movements are difficult to distinguish from the anti-dictatorship movements and in many occasions arose directly within. Through the 1970s the antinuclear protests remained rooted in strong regional identities – particularly so in the case of the Basque and Catalan regions (Rüding 1990, 216). Yet opposition to nuclear power also came from people within Franco's regime (mayors, provincial governments, religious associations, agricultural unions, etc.) expressed their dissatisfaction and opposition to the decisions to locate nuclear power plants in their territory." *(page 16)*

Event 2: Ascó

"In this way, Ascó activists looked for support among scientists and lawyers, they established links with the academic world of Barcelona and together with it links to well-organised political movements who fought against the Franco regime." (page 41).

Event 3: Basque antinuclear movement

"The (then) recently legalized political parties should make their position known within the conflict. With broad stroke, organizations of the left and extreme left positioned against Lemóniz (with great prominence of radical "abertzale" – Basque nationalist on the far left- which made anti-nuclear speech one of their hallmarks), while right-wing parties are pronuclear (including a Christian Democrat party as PNV –the Basque nationalist on the right)." (page 46).

"Through the 1970s the antinuclear protests remained rooted in strong regional identities. In the Basque case it crossed the line of violent action (over 300 attacks, 13 lives). The Committee for the Defence of a No Nuclear Basque Coast (CDCVNN) formalized in May 1976, amalgamated antinuclear neighbourhood associations, cultural groups and, professional associations. Their commitment with the defence of the territory steam from the possibility of a serious accident in Lemóniz. Such event "would mean the disappearance of the Basque people, and the disappearance of Euskadi as a political project"." (page 47).

- *Period 1990-2015*

In Ukraine, the anti-Chernobyl protest became part of a broad independence movement that was centred to a large degree on environmental concerns (Showcase, Event 2). Chernobyl became a symbol of colonial power and fuelled the independence movement. However, later public opinion seems to realize that nuclear energy was a condition for national independence, leading to a kind of "reluctant acceptance" (in terms of Bickerstaff et al. 2008) of it. The issue of "reluctant acceptance" for nuclear power like a condition for national survival was raised among receptors (Event 5), even if the negative consequences of Chernobyl continue to haunt Ukraine, some of the public opinion still think that nuclear energy is the condition for the national survival.

General narrative

"The explosion of reactor four on April 26, 1986, led to heavy radioactive contamination of regions of Ukraine, Belarus and Russia. After the extent of the disaster was finally revealed to the general public in 1989, a broad independence movement developed that was centred to a large degree on environmental concerns and the belief among many participants that Moscow's Russian-centred economic development policies had contributed to the degradation of Ukraine. In response the Ukraine parliament in August 1990 voted to adopt a moratorium that lasted until 1993 on the construction and commissioning of new nuclear power units." (page 8).

Showcase: Dealing with Chernobyl disaster aftermath

"The pre-eminence of nationalist movements in the Chernobyl protests led to the "nationalization" of dominant public narratives of the Chernobyl disaster. The accident appeared in public discourse first of all as a crime of colonial communist authorities – in Moscow, in the Kremlin – against Ukrainian nation and its people. They considered full-blown political, economic and cultural independence of the nation as the only possibility both for a national renaissance and to save people from Chernobyl (Dawson 1996; Phillips 2004: 159-85)." (page 42).

Event 2: Post-Chernobyl anti-nuclear protests and vote on the moratorium on the construction of the new nuclear reactors (1989-1991)

Chernobyl was seen as a **symbol of Soviet colonial power** by those receptors, which were among the nationalism and environmental activism movement. They believed that officials in Moscow took the decisions about building nuclear power plants in the republic **without considering the potential danger** to the Ukrainian people and local environment (page 43).

Event 5: Start-up of the Kmelnytska 2-Rivne 4 nuclear reactors (2004) as part of strategy aiming at "nuclear revival" and new public information effort

"These depictions of nuclear power convey the message that Ukraine accepts this technology, is strengthened by it and protected from its negative impact. Even if the negative consequences of Chernobyl continue to haunt Ukraine, the nation, those pictures show, cannot do without nuclear energy: nuclear energy is a predicate for national survival." (page 57)

In spring 2015 Energoatom organized an artistic competition and a teenager from Varash (formerly Kuznetsovsk), the town near the Rivne NPP, won the first prize telling the story of a boy, whose father leaves home to go to war and defend his Motherland (page 58)

A.3.3. Cultural traditions, values and lifestyles (including military imagery)

The maintenance of certain traditions and lifestyles, certain patterns of social relations, certain cultural values and social principles and beliefs, are part of this set of factors influencing public perceptions about nuclear energy.

- *Period 1950-1970*

No mention of this dimension in the SCRs for this period.

- *Period 1970-1990*

According to the Finnish SCR, modernization of Finland received very few critical comments (General narrative). The values of the post-war generation included a positive view of technological progress and of nuclear. Later, environmental movements promoted energy saving, environment protection and new life-styles grounded in the idea that less consumption required less energy. Besides, in the SCR is said that there is collective memory that shapes the interaction between Finland and Russia/Soviet Union regarding nuclear energy issues (Showcase).

General Narrative:

"Industrialization and modernization of Finland received very few critical comments. Men who had fought the wars and women who had waited for them at homes engaged in building the welfare society and they saw no reason to criticize the progress. Although industrial and urban development destroyed the old Finland, no organized resistance was found. The most intense debates took place in Kuusamo, North-Eastern part of Finland, where power companies struggled to gain ownership to the last free flowing rivers (Käsmä 2015)." (page 22)

"The post-war generation was strongly influenced by ideas and ideologies developed in Europe, the United States and the Soviet Union. Although political flags were different, the goals, aims and values were more or less the same. The post-war generation questioned beliefs in continuing economic growth, imperialism, colonialism and the nuclear arms race. Young generation developed ideas of global village, world peace and sustainable economy and environment (Virtanen 2012)." (page 23)

"Environmental and anti-nuclear groups opposed this view and encouraged the industry, communities and municipalities to look at the energy demands critically. In order to save energy and environment, new life-styles should be introduced and adopted. Less consumption required less energy." (page 24)

Showcase: Collective memory and the uneasy nuclear collaboration between Finland and Russia/Soviet Union

"In sum, we assume and even argue that there is collective memory that shapes the interaction between Finland and Russia/Soviet Union in nuclear energy." (page 32)

In Spain there are some perceptions linked to the desire to maintain certain forms of life (such as a rural or fishermen's life) (Event 1). Another issue is the moral dilemma the anti-nuclear movements in the Basque Country had to deal with, i.e. how much to accept that terrorist violence can be useful for its presumably peaceful purposes (Event 3). This shows us a conflict of values between several actors shaping public perceptions.

Event 1: Vandellós I

Concerns were also raised at this stage by the fishermen from the coastal region, worried about the potential pollution of marine resources and their way of life (Le Monde, 03 April 1975) (page 36)

Local governments related to the fact that the population is "familiar" with the risks. This is especially so in the case of Vandellós, where in the 1980s a second reactor was installed. Apart from the familiarity, the access to information about the risk management provided by ENRESA is highly valued (page 37).

Event 3: Basque antinuclear movement

The social perception of the Basque anti-nuclear movement has been marked by terrorist violence against the only NPP that began building in Euskadi: Lemóniz (page 45).

After many violent acts happened, the private project was nationalized (by the Government). The antinuclear movements faced a moral dilemma: to accept, reject or live with terrorist violence to achieve their goals (page 48).

In Sweden, one of the objections expressed by some Receptors was the need to advance towards other energy models based on renewable sources and efficiency measures (Event 2), equating to a request for a more sustainable development model, which refers to alternative worldviews.

Event 2: TMI and the referendum on nuclear power

"Furthermore it (antinuclear movement) proposed a fast development of renewable energy sources and of more efficient energy use. Such a development, it was argued, would make it possible to phase out the six operating nuclear

reactors in ten years and replace them primarily with renewables and efficiency measures.." (page 33)

- *Period 1990-2015*

Public perceptions in Bulgaria seem to have been affected by the change of political and social model due to the fall of the communist regime (Event 3). The Green organization – Ekoglasnot, acted as catalyser of people concerns on nuclear power, becoming a stake in times of political and social changes.

Event 3: Reaction of the Green movement to the Chernobyl accident

Three years later in the end of 1989, the Bulgarian communist regime collapsed, at that time **the doors for political and social changes** were opened. The Green organization – Ekoglasnot, with no pure political aims acted as catalyser of people concerns on nuclear power, kept its main themes and demands for environmental prevention and information. One of the main questions remained about what were the consequences of Chernobyl accident (page 38).

- **Relation to military imagery**

In some countries public perceptions of nuclear energy were also shaped by the military concepts or imagery. The possibility of building (and using) nuclear weapons is present in several of the SCRs as a factor shaping the public perceptions.

- *Period 1950-1970*

In the F.R. Germany report, it is said that military strategic considerations influenced siting decision; and this pointed out to military aspects of the peaceful use of nuclear power in early West Germany. "Although the scientific community tried hard to present nuclear science as a strictly civilian endeavour, not least to strip it of its historical origins in the so-called "Uranverein" (a project to develop nuclear weapons) under National Socialism, military rationales did play a substantial role in West Germany's early nuclear history" (Event 1, p. 24).

Event 1: German Atomic Program – First Nuclear Research Center

"The intervention of the NATO Supreme Allied Commander Europe in the siting conflict points to the interrelations of the civil and military dimensions of the nuclear sector. Although the scientific community tried hard to present nuclear

> science as a strictly civilian endeavor, not least to strip it of its historical origins in the so-called "Uranverein" (a project to develop nuclear weapons) under National Socialism, military rationales did play a substantial role in West Germany's early nuclear history (Kelleher 1975, Cioc 1988, Küntzel 1992, Hanel 2015) (page 24).

The Finnish SCR shows how it was not easy to separate the civilian and military applications in nuclear technologies (Events 3 and 6). This lead to the opposition movements to be critics with the nuclear program appealing to anti-nuclear weapons treaties and laws.

> *Event 3: Transnational organizations and the Cold War politics*
>
> "EURATOM and the US Congress agreed in August 1958 that the nuclear power plants in Western Europe should be built under the US supervision. From the Soviet point of view this agreement created a bilateral bridge between the United States and Western Europe for the technology transfer. Although the agreement was specifically only for the civilian nuclear technology, it was impossible to separate the civilian and military application in nuclear technologies. The Kremlin government interpreted it as a hostile act against the Soviet Union. (Fisher 1997)." (page 40)
>
> *Event 6: First nuclear debates*
>
> "Heikki von Hertzen also complained that IVO's plan violated the Finnish foreign policy. President Kekkonen had initiated in 1963 "The Nordic Nuclear Free Zone". The initiative was made right after the world had witnessed the Cuban Crises and almost the Third World War. The President was afraid that similar situation could take place in the Baltic Sea region. The Nordic Nuclear Free Zone eliminated the risk of nuclear war by prohibiting nuclear weapons in the Nordic region. IVO's plan challenged the initiative, because; "fission reactors are a part of the military industrial complex and they produce plutonium. All reactors produce plutonium and therefore it is possible that plutonium ends in the hands of terrorist or military groups that can built nuclear weapons."" ((page 56)

Protective defence purposes were mentioned in Sweden (Event 1). Among regulators the controversy was based on the purpose for the atomic weapons research (how research could be conducted). Concerning receptors there was less controversy on this matter; they understood research on how to protect Sweden for the risk of nuclear weapons from other countries. The receptors directly related the development of atomic weapons with their security and also with a perceived increasing risk of war. In this sense, opponents of nuclear weapons were concerned by an increase in the risk of atomic warfare affecting Sweden (Event 1).

> *Event 1: The atomic weapons controversy*

> The choice was between on the one hand "protection research" aiming at understanding nuclear weapons better in order to construct bomb safe shelters and other protective devices, and on the other hand "construction research" aiming at constructing and producing nuclear bombs (page 36).
>
> The opponents of atomic weapons argued that such weapons would be detrimental to Swedish security and increase the risk of nuclear warfare affecting Sweden. Some of them further argued that Swedish security would increase if the resources used for nuclear weapons research were used for development aid instead (page 40)

In the UK, maintaining the country's place at the 'top table' of international politics in Cold War times seems to have been the motive for appealing to nuclear weapons (Event 1). Nuclear weapons were tried to be shown as symbol for the British supremacy for the regulators/promoters. Although the issue of Britain's nuclear weapons became controversial, publicly and politically, opinion on the topic varied from supporting unilateral disarmament to supporting continued development of nuclear weapons. On the receptors' point of view, public reactions were towards the use of nuclear weapons but not on the nuclear power, in a period of public trust on political institutions. However, some early movements started with a growing concern about nuclear weapons throughout the 1950s.

> *Event 1: First nuclear weapons test 1952*
>
> Established to protest against increased global stockpiles of nuclear weapons, and to agitate for British unilateral disarmament. (page 31)
> For the government, the major reasons for going ahead **were prestige, and to maintain Britain's place at the 'top table' of international politics (page 31).**
> In the press, the weapons test was presented to the public by the news media as a major success of independent British engineering and ingenuity at a time of austerity (page 31).
>
> This was a period of trust in government and institutions in general, and as such there is very little initial evidence for anything other than public acceptance of this narrative.(Blowers, 2010b; Hennessy, 2007) However, throughout the 1950s a growing concern about nuclear weapons began to emerge (page 31).

- *Period 1970-1990*

According to the Ukrainian SCR, sometimes public authorities' responses facing nuclear incidents were framed in a 'war' context against external enemies. This can be seen in the Chernobyl case, treated by the Public authorities as "an external enemy that Soviet people must fight" (Event 1).

More generally, the use of military rhetoric and images was pervasive in the Soviet media at the time. Soviet troops and military equipment were heavily involved in the Chernobyl clean-up and evacuation operations.

> *Event 1: Chernobyl disaster (April 26, 1986)*
>
> ""The official term of "liquidation" reflected well such aspects of the Soviet post-accident policies as treating the disaster as an external enemy that the Soviet people must fight and annihilate. It also described accurately Soviet authorities' efforts literally to erase the accident, to make the traces of it disappear both from the environment and the public sphere." (page 35)
>
> "More generally, the use of military rhetoric and images was pervasive in the Soviet media. Soviet troops and military equipment were heavily involved in the clean-up and evacuation operations. The "war frame" has since become extremely important in public narratives and people's recollections of the disaster (Kasperski 2012: 110-128; Phillips 2004,164-165; Marples 1993). One of the reasons for this is the importance of the public memory of World War II in former Soviet countries. During the Soviet period, the Communist Party created a full-blown cult of the Great Patriotic War (the period during which Soviet Union was in war with Nazi Germany), or more precisely of the victory of Soviet state and people over fascism to reinforce its legitimacy (Tumarkin 1994)." (page 36).

In the USA report it is said that some environmental movements (as such Abalone Alliance) were critics with the direct relationship between civilian and military nuclear power. (Event 2, p. 35)

> Abalone Alliance members worried about (…) the direct relationship between civilian and military nuclear power (…) (Direct Action, 1981)
>
> (Event 2, p. 35)

- *Period 1990-2015*

No mention of this dimension in the SCRs for this period.

A.4. Political-institutional dimension

According to the interpretative and contextual theories of risk (Horlick-Jones, Renn, Wynne, etc.) it is not so easy to separate perceptions of nuclear issues from their social, economic or political context of production. We should consider that when people evaluate a technology or activity, they are also implicitly making an evaluation of the institutions that promote, manage and regulate it, and generate a judgement about the credibility or trustworthiness that it deserves. From the analysis of the SCR we have deduced several topics related to this political-institutional dimension:

- Trust and confidence in institutions (both promoters and regulators).
- Governance issues (related mainly to political games and energy dependency).

A.4.1. Trust and confidence in institutions

This section covers all perceptions of nuclear energy affected by trust or distrust in the institutions that promote or regulate it. Distrust is related to the perception that these institutions have carried out some kind of incorrect or unethical behaviour, for example by favouring private interests above the public, by acting against the law or by keeping secrets (which at some point were revealed to the public). In fact, we have found several cases where the public raised concerns about the secrecy of the information provided by promoters and/or regulators.

- *Period 1950-1970*

The UK is the country where the Regulators seemed to have been trying to achieve more trust from the public. Although the Windscale fire (Event 3) had little impact on the nuclear power programme at the time, the combined impact of the incident itself, the government's handling of it, and the secrecy surrounding it, led to a decrease in trust in the institutions involved. This generated notable criticism of the government and changes to the manner in which nuclear power was debated and perceived.

Event 3: Windscale Fire 1957 However, the report released by the government (some months after the fire) claimed that the cause was human error

by well-trained but unfortunate plant staff (page 36).

Although impacting little on the developing nuclear power programmes of the 1960s, the Windscale fire, the government's handling of it, and t**he secrecy around it have decreased trust in the institutions involve**d by the receptors (page 37).

According to the USA SCR the regulators lost the trust of the people. Yet from the start the AEC suffered from two weaknesses in the effort to promote nuclear power: first, in early times the AEC commissioners were fully beholden to military interests; second, the agency looks as it was "captured" by the industry it was meant to regulate. (General narrative). Other sources of distrust were found in the promises made by Promoters and Regulators that later were not fulfilled or turned out to be false. For instance, yet in spite of the precautions in the design and construction of the Fermi reactor, and in spite of the reassurances by the scientists that a serious accident could not happen, one did occur. (Event 1) Finally, according the SCR, the regulator (NRC) seemed to put industry interests ahead of public concerns that were based on accurate evaluation of seismic data and risk, even though at Bodega Bay in the 1960s forced regulators to include seismic data in a standard licensing process. (Event 2). In sum, since early times, and according to its critics, the regulators (AEC) too often assumed a promotional, not sufficiently regulatory role (Appendix 3), which could easily lead to the public distrust.

In the end, with the passage of the Atomic Energy Act of 1946 (the McMahon Act), the US government created the Atomic Energy Commission (AEC) to establish civilian control – not military – over this nuclear knowhow and technology. By the late 1940s and 1950s, a series of research programs using experimental reactors, isotopes, and the like established the likelihood of applications from power generation to medicine, industry, and agriculture, and to transportation that developed largely in AEC-controlled national laboratories. Yet from the start the AEC suffered from two weaknesses in the effort to promote nuclear power. One was that, at least initially, the AEC commissioners were fully beholden to military interests; the unfolding Cold War and fear of communism led to a headlong rush into designing and testing better nuclear weapons. The second is that, like so many other regulatory agencies, the AEC ultimately was "captured" by the industry it was meant to regulate, and when it embarked on civilian power production this was reflected in a closed managerial style that was handicapped by the absence of sufficient internal expertise to ensure that reactor design and siting erred always on the side of civilian safety.

(General narrative) (p. 6)

This led the House and Senate to pass the 1954 Atomic Energy Act to promote private development of nuclear

energy, with the AEC providing a variety of incentives and, in the eyes of many critics, paying inadequate attention to various safety issues in the effort to promote nuclear power. As Mazuzan points out, the 1954 AE Act gave the private sector right to own nuclear materials and operate its own nuclear facilities: "Under the broad authority of the 1954 Atomic Energy Act, the AEC pursued a policy based on the premise that private industry could bring about economically competitive atomic power faster than a government-run program. This policy reflected the pro-business orientation of the Eisenhower administration. Success rested in large measure with AEC chairman Lewis L. Strauss, a strong-willed man with a remarkable talent for being constantly at the center of stormy controversy."(Mazuzan, 1980: 342)

(General narrative, p. 7)

Detroit Edison directors believed private sector should build and run the next breeders, and by 1952 they created a not-for-profit division, the Power Demonstration Reactor Corporation (PDRC) to look into building a reactor and entering the nuclear age. As John Fuller writes,

The developers of the Fermi breeder reactor were very sincere, diligent, and highly qualified individuals to whom the safety of the reactor was paramount. Extreme care was taken to insure against the possibility of a serious accident occurring. The scientists involved were most confident that they had covered all possible problem areas. They had built safeguards on top of safeguards. Yet in spite of the precautions in the design and construction of the Fermi reactor, and in spite of the reassurances by the scientists that a serious accident could not happen, one did occur. (Fuller, 1975: 54)

(Event 1, p. 30)

announce groundbreaking for the construction, not to indicate any circumspection.(Fuller: 56)

In 1959 the AFL-CIO under Walter Reuther filed a brief that the US Court of Appeals upheld in 1960 that the construction permit for the Enrico Fermi LFMBR plant was illegal and that building would have to stop within fifteen days. But the US Supreme Court quickly overturned that decision, 7-2, declaring that the AEC had been within its rights in permitting the Fermi reactor to be built and that final construction could proceed unhindered. In the majority decision, Justice Brennan stated that the AEC had found "reasonable assurance for present purposes, and that is enough to satisfy the arguments of law," and that a step-by-step process of licensing to operation ensured safety.

(Event 1, p. 31)

Three years and nine months later, Detroit Edison restarted Fermi 1. The UCS termed the AEC's role following the accident "more like that of a hall monitor" for its passive review, occasional inspections, and no effort to audit recovery effort, let along learn from the accident.(UCS. 1970?: 4) In November 1972, having failed to operate the unit at any level close to specification, PRCD determined to decommission Fermi 1,

(Event 1, p. 31)

The regulators (AEC → NRC) lost the trust of the people. The NRC seemed to put industry interests ahead of public concerns that were based on accurate evaluation of seismic data and risk, even though at Bodega Bay in the 1960s (NPP rejected by AEC, proposed by PG&E, north of San Francisco, see country report) forced regulators to include seismic data in a standard licensing process

(Event 2, p. 33)

In the effort to encourage rapid commercialization of nuclear power, the AEC encountered the challenge of balancing public safety with promotion of nuclear power at a stage when the technology of commercial reactors was at an early stage of development. (…)As a result, the AEC too often assumed a promotional, not sufficiently regulatory role.

(Appendix 3, p. 75)

- *Period 1970-1990*

The secrecy of information provided by public authorities is present in the Bulgarian SCR (Events 2 and 3), which frames the public perception of the government itself. This generates a situation of distrust of the government as a communicative actor.

Event 2: Starting the NPP Kozloduy and the Vrancea earthquake – 1974-1977

"Notably, the agreement also specified the secrecy of technical information: None of the organizations involved was to reveal the provided documentation to entities or organizations of other countries." (page32)

"As the implementation of this nuclear power project was approaching, opposition voices became stronger. This opposition was rooted in the struggle between different groups, in particular the political, economic, and scientific nomenclature. (page 33)

Event 3: Reaction of the Green movement to the Chernobyl accident

"One of the main questions remained the consequences of Chernobyl accident. On the meeting on 20th of October 1989 for the first time, the truth about Chernobyl accident and consequences were presented and discussed. A report about the criminal behaviour of the communist ruling elite finally shed light on the truth." (page 39)

In the F.R. Germany lack of trust in government and regulators seemed to be a popular point of criticism among the groups against nuclear energy. The criminalization of antinuclear activists

was interpreted as a source of mistrust among the receptors, leading to a lack of trust in government's willingness to seriously consider people's concerns (General narrative). Left-wing critics perceived this collusion between the state, the regulators and promoters in terms of left-wing ideas. Ideas of the high-security 'nuclear state' also played a role in this debate (Showcase).

General narrative

Large parts of the population frequently mistrusted both the state and the energy industry (page 6*).*

Moreover, receptors opponents to nuclear development doubted alternative energy supply problems and disapproved of the **lack of political will** to actually invest it (page 6).

"*This **mistrust in the truthfulness** of state and nuclear industry justified for activists' militant actions. The police's brutal responses to militant acts and the obvious intention of some politicians to **criminalize dissidents** only **increased skepticism and suspicion** against authorities and utilities*" (page 14).

Showcase:

"The German engineer Klaus Traube was managing director of Interatom, which had built the nuclear reactor SNR-300 in Kalkar. Originally a proponent of nuclear power, Traube reconsidered his views in the early 1970s after having read the Club of Rome's The Limits to Growth. When the German secret service suspected (falsely) that he had passed on secret information to the Red Army Faction (RAF), they illegally wiretapped Traube's apartment and he lost his job because the Federal Intelligence Service (Bundesnachrichtendienst or BND), one of the three German secret services, informed his employer about the issue. The illegal operation was uncovered in 1977, Traube was cleared of all charges, and the government was plunged into a crisis, as a result of which the then federal minister of the interior, Werner Maihofer, was dismissed (Mrusek 2011). " (page 20)

Event 4: Gorleben (repository site)

Government's handling of it **was perceived as inappropriate** by the anti-nuclear movement and the broader public alike (page 31).

In Spain the promoters began building the Ascó NPP (Event 2) without the compulsory reports and official permits. In all cases, the public authorities later legalized those illegal works (Showcase, Events 2 and 3). The legislation was adapted to the NPP interests generating great distrust among the public (receptors). There were also cases where the Promoters did not tell the truth about their intentions when acquiring land for siting the NPPs (they said they want to promote chocolate factory in Event 2). This increased distrust among an important part of the affected people.

Showcase: Valdecaballeros

"The (nuclear) companies had also hired personnel and began building on site in June 1975 despite the **lack of the preliminary reports** from the water authorities, the environmental evaluation by the national and regional governments, the proper expropriation of the affected lands, and the required construction permits. Some of these issues were legalized by government decree in 1979, when the government –now democratically elected – gave the definitive authorization for the construction of the plant, which was well advanced already." (page 23).

Event 2: Ascó

"The NPP compelled all its employees to take up residence in Ascó so that they could vote in local elections and in this way contribute to decisions inside the municipality which favoured the nuclear plant ." (page 42).

"As in another cases it was the property developers' strategy to hide the real reason for acquiring land in the municipality by pretending to build a "chocolate factory" until it was leaked that the real reason behind it was to build a nuclear power plant which to the people deep in the countryside did not mean much." (p.38-39)

Event 3: Basque antinuclear movement

"Iberduero, the promoter, did not apply for definitive building permit until September 1976, and for the required reclassification of the land from rural and natural to industrial uses until March 197." (page 45).

The UK is the country where the Regulators seemed to have been trying to achieve more trust from the public. They emphasized the need of guaranteeing the choice of the safest available nuclear reactor technology (Event 4).

Event 4: SGHWR chosen as AGR replacement 1974

The Secretary of State for Energy, Eric Varley was above all concerned that 'the Government's choice of nuclear reactor would command public confidence' and determined that in light of 'the recent disaster at the chemical plant at Flixborough' the government should choose the safest option (page 39).

In Ukraine the affected population (receptors) perceived a lack of information flow regarding the Chernobyl accident (general narrative) and even a falsified narrative about how the management was done (Event 1). Public trust seemed severely damaged in Ukraine by the event and the associated secrecy surrounding its consequences and management, which played a key role in the resistance of Ukraine against Soviet rule. However, key changes in the political scene in Ukraine led also to changes of public attitudes towards nuclear power, in the sense that they reacted less once Ukraine was constituted. The antinuclear local mobilization from the receptors

contributed to the moratorium on the construction and commissioning of new nuclear power units. Public trust had been severely damaged by the event and the associated secrecy surrounding its consequences and management, which played a key role in the resistance of Ukraine against Soviet rule, with many experts proposing informational and educational work with receptors as a method to address such mistrust, reflecting the knowledge deficit model of gaining support through the provision of scientific facts to create a better informed public and therefore overcome societal concerns. Regarding how regulators managed information, the receptors perceived a lack of flow of information to act adequately in an emergence status. In general, there were great fears it may collapse or decay and trigger another nuclear incident. This lack of management and/or coordination from the authorities in dealing with the accident could be noticed among the receptors.

General narrative

After the dissolution of the Soviet Union, public attitudes (receptors) toward nuclear power changed dramatically and the **belief** among many participants that Moscow's Russian-centred economic development policies had contributed to the degradation of Ukraine (page 8).

"Ukraine has achieved little beyond political declarations. Among the main reasons has been the unwillingness of authorities and the people to pay the high costs necessary to restructure the economy and to modernize the industry. More important, the energy sector is extremely corrupt and controlled by private or corporate interests, that is, groups who profit greatly from the current situation and oppose to any changes (Balmaceda 2008: 65-143)." (page 11)

Showcase: Dealing with Chernobyl disaster aftermath

Ukraine gained independence with the break-up of the USSR in 1991 with a nuclear moratorium in force and the public fully against nuclear power (page 25).

The Chernobyl disaster has had a tremendous impact on the development of the nuclear power not only in Ukraine and former Soviet countries, but throughout the world. The accident and its aftermath are also crucial to understand very different types of interaction between the nuclear establishment and society: secrecy, disinformation or other communications on nuclear technology and its dangers; anti-nuclear protests related to nuclear power; and new forms of nuclear communication and public participation procedures put in place to remediate post-Chernobyl public distrust *(page 33.)*

More than three decades after the disaster, controversies continue to rage over what made such an accident possible and what are its on-going public health impacts. These debates remain essential to the discussions about the future of the nuclear power as well as about the relationship of industry with the public not only in Ukraine but in other parts of the world. A number of reports, studies, testimonies and memoirs have described Chernobyl accident as due to

inherently Soviet causes, and thus impossible in other countries. Yet in her recent study of Soviet nuclear program and official and dissident experts' explanations of the accident, Sonja Schmid (2015) warns against such simplistic accounts (page 28).

Event 1: Chernobyl disaster (April 26, 1986)

Soviet authorities made all efforts available to show an **optimistic and heroic narrative** about successful "liquidation" of the accident's consequences and the return to a normal life in Soviet media. As well as to make clear the efficiency of the central and local authorities in dealing with everyday problems related to evacuation, health control, cleaning-up operations. (page 35).

At the same time, the receptors **lacked trust** on this official optimistic discourse about the liquidation of the disaster consequences. The SCR described that interviews with inhabitants and analysis of archival sources show that many of local inhabitants of the areas close to the accident site were aware that the accident at the nuclear plant was far **more serious and dangerous that officials wanted to admit**. Soviet authorities as regulators/promoters are described in the SCR how they tried accurately to erase, to make **the traces of the disaster disappear** both from the environment and the public sphere (page 36).

Among local population the **secrecy** resulted in insufficient and inadequate measures of protection for the nearby population and emergency workers sent to do the clean-up of the accident site and the villages in its vicinity (page 37).

Event 2: Post-Chernobyl anti-nuclear protests and vote on the moratorium on the construction of the new nuclear reactors (1989-1991)

Activists, new political representatives, Ukrainian public intellectual and scientists involved in the protests **denounced the secrecy of the information** on the disaster consequences during first years after the disaster, **the mismanagement** of the radioactive fallout impact that criminally jeopardized the health and life of the Chernobyl victims, and they voiced **claims for extensive emergency protection measures** and relocations and compensation payments (page 41).

As the regulators/promoters did not stop moving forward with the construction of the new reactors in Ukraine, the receptors had a strong resentment of the Moscow reinforced by fears of new accidents. Receptor's **distrust** towards nuclear power was raised in the atmosphere of secrecy typical for the Soviet management of the civil nuclear projects always closely related to the military uses of atom (page 42).

Like the partisans of the "public understanding of science" ideas in the '70s in western countries, they believed that to restore the prestige of nuclear science and technology and overcome people's fears they needed to produce a better informed public (page 44).

According to the USA SCR, the Regulator (AEC-NCR) is seen as low trustworthy due to several non-congruent behaviours. First, for its supposedly inefficient functioning ("the NRC routinely

licenses plants on extremely thin financial, safety, and environmental evidence") (General narrative, p. 11). Second, the licensing of the Diablo Canyon Nuclear Power Station revealed the ad hoc nature of the regulators (AEC and NRC's) treatment of seismic characteristics in adjudicating safety concerns and points to why many citizens do not trust either the NRC or the utilities. (Event 2). Third, in the aftermath of the TMI accident, the Kemmeny Report indicated the poor regulatory operations of the NRC (Event 3). Finally, the Regulator (NRC) lost a great deal of trust among people when it accepted an industry-sponsored emergency evacuation plan, in a place where geographic and demographic characteristics of the seacoast area make it difficult to evacuate safely under any conditions. (Event 4)

He demonstrated clearly that the NRC routinely licenses plants on extremely thin financial, safety, and environmental evidence. For Seabrook NPP neither state nor federal environmental review had a significant impact on the choice of sites or the range of alternates considered. As others have noted, the NRC all too often and in this case accepted the utility's safe information on faith since it lacked capability to make independent evaluations. Stever concluded that time-consuming licensing processes were more the result of the NRC's inefficient way of doing business, not the product of environmentalist delay tactics. All of this called for a more independent and objective NRC.(Stever, 1980: 168).
(General narrative, p. 11)

In the 1970s it became clear through an FOIA (Freedom of Information Act) request from Friends of the Earth that the AEC had actually suppressed publication of a 1964 update of WASH-740 (US AEC, 1957), a reactor safety study, that estimated a worst-case scenario accident leading to at least 3,400 deaths and $7 billion of property damage, well over the amounts covered by the indemnities of the Price-Anderson Act with a limit on liability of $560 million.
(Event 2, p. 34)

The licensing of the Diablo Canyon Nuclear Power Station revealed the ad hoc nature of the AEC and NRC's treatment of seismic characteristics in adjudicating safety concerns and points to why many citizens do not trust either the NRC or the utilities. The rulings and evaluations indicated the difficult effort to balance the accepted need for power generation with public concerns and safety.
(Event 2, p. 36)

The Kemmeny Report indicated the poor oversight and regulatory operations of the NRC: "To prevent nuclear accidents as serious as Three Mile Island, fundamental changes will be necessary in the organization, procedures, and practices -- and above all -- in the attitudes of the Nuclear Regulatory Commission and, to the extent that the institutions we investigated are typical, of the nuclear industry. This conclusion speaks of necessary fundamental changes. We do not claim that our proposed recommendations are sufficient to assure the safety of nuclear power."(Ibid.: 7)

(Event 3, p. 41)

The NRC lost a great deal of trust among New Englanders when it accepted an industry-sponsored emergency evacuation plan for 10-mile radius. Massachusetts Gov. Michael S. Dukakis has refused to file plans for the northeastern Massachusetts towns, contending that geographic and demographic characteristics of the seacoast area make it impossible to evacuate safely under any conditions.
(event 4, p. 45)

- *Period 1990-2015*

Finland has a governance system including authorities, nuclear companies and government agencies deciding together in closed cabinets, but having high levels of trust among public opinion. However, during last times some projects are accumulating troubles and nobody is able to say when the power stations were ready and how much they would eventually cost. (General narrative, p. 5, p. 19).

General narrative

"One key concept is the "triangle of power". Nuclear power projects in Finland have been controlled and governed from the day collectively by authorities (Radiation Safety Agency), nuclear companies (IVO/Fortum and TVO) and government agencies (AEN, KTM). This triangle of power has had almost unlimited powers to establish the rules of the game and enforce rules in all situations and all circumstances." (page 5)

"Nowadays Olkiluoto NPP attracts a dramatic attention because in 2003 the energy company Teollisuuden Voima (TVO) received a permission to finally build the "fifth reactor" in Finland. This reactor has been planned, debated and decided for more than 20 years. The French company AREVA and the German company Siemens are jointly constructing the nuclear power plant that should have been commissioned by 2010 but the project is still unfinished. Therefore, Olkiluoto project is scrutinized by social scientists, historians and environmental scientists because its completion accumulated various problems and troubles." (page 10)

"TVO's project was plagued by labor and management problems. According to the initial time table both nuclear power stations were supposed to feed electricity to the national grid by 1970, but the deadline was pushed back year after year. Finally nobody was able to say when the power stations were ready and how much the project would eventually cost (Michelsen-Särkikoski 2005)." (page19)

Showcase: Collective memory and the uneasy nuclear collaboration between Finland and Russia/Soviet Union

"This strange arrangement has been criticized in Finland but nothing has been done to change the situation. The Finnish government had number of occasions to stop the project and cancel the deal with Rosatom. The Finnish

parliament has also had several occasions to put the end to the project. However, Fennovoima moves on, although it has broken rules and regulations, and time after time the authorities have complained the management of the project." (page 31)

Event 4: Surprise in Moscow

"Imatran Voima (IVO), the state owned energy company had struggled to find a contractor for the first nuclear power station. The international bidding had started already in 1965 and after two unsuccessful rounds IVO was not able to declare the winner. The Finnish government had terminated the process, but because of the political pressure from Moscow, the negotiations were restarted in 1969. The group of men in black had come to Moscow to learn more about the offer made by the Soviet nuclear power company Technopromexport. (Särkikoski 2011)." (page 43)

Event 5: Becoming the "Atom town"

"IVO's nuclear power project was sliding into a total catastrophe. The company was committed to evaluate fairly all offers, but the project was eventually decided by the Finnish and Soviet governments. This would tarnish IVO's domestic and international reputation for good." (page 50)

In the Spanish SCR the issue of vested interests was raised by several actors (mostly regarding supporters of a waste repository (Event 5). The existence of contradictory external reports (about the siting features or nuclear impacts) was a source of distrust among the actors too.

Event 5: NWR

Part of the local population distrusted the mayor of Ascó, as he was perceived to be linked to the nuclear industry and, therefore, with **vested interests (page 54)**.

Environmental associations, such as Greenpeace or Ecologistas en Acción, criticised the performance of the Nuclear Safety Council (CSN) as, in their view, the regulator submitted the preliminary authorization for the site **without enough information**. In their view, Villar de Cañas was chosen for political reasons; there was no technical reason to justify it, neither the quality of the place nor the proximity of nuclear installations (page 56).

The regional government argues **irregularities in the planning**; and alerts of no safety guarantees because **contradictory external reports (page 58).**

The Provincial Council (PP) highlights **vested interests** of La Junta de Castilla-La Mancha (regional government) to stop the economic development of the province (Cuenca) (page 56).

In the UK some receptors showed a lack of trust in the reactor management performed by private companies following a culture of secrecy (Event 7). The receptors demanded more public information about power stations, and this was especially the case in local communities affected.

General narrative

"At first the Labour governments of 1997-2010 avoided taking any decision on nuclear power (or nuclear weapons).(Adams and Eaglesham, 2005) The early 2000s, however witnessed a conjunction of the depletion of North Sea gas reserves from 2005 (changing Britain from a net energy exporter to an energy importer), a capacity crisis (caused by ageing plant) and the growing importance of climate change mitigation." (page 30)

"Cabinet concluded that public confidence in the nuclear programme necessitated the choice of the safest possible reactor (even if it wasn't the cheapest) and supported the construction of SGHWRs.(Cabinet Conclusions, 1974) This event shows how the balance of this decision rested on the construction of an 'imagined public' by Ministers who valued safety over cost.." (page 28)

Event 7: Government repositioning on new build NPPs 2006

"Although the 2008 consultation showed public acceptance of a role for nuclear energy in providing the UK with low-carbon electricity, it did highlight a lack of trust in the privatised operators of nuclear power plants. Members of the various consulted groups were concerned that private companies would be less prepared than the government, or a public sector body, to take choices which were expensive but safer: "Would they try to get away with only minimum standards due to concerns about their profits?"." (page 50)

In Ukraine, at regulators level, the debate was on the European West-East distrust situation, as western partners should assist Ukraine on exchange of closing Chernobyl. Ukraine officials were disappointed by the Western partners who, according to the Ukrainian side, failed to fulfill their 1995 commitment to assist the country in exchange for closing the Chernobyl plant. For instance, the Western side didn't provide the funds necessary to complete K2-R4. (Event 4, p. 21).

Event 4: Controversial negotiations on the closure of the Chernobyl NPP and public hearings on the completion of the Kmelnitsky 2-Rivne 4 nuclear reactors in exchange (1994-2000).

"Ukrainian officials were disappointed by Western partners who, according to the Ukrainian side, failed to fulfil their 1995 commitment of assistance to support Ukraine's energy sector in exchange for closing the Chernobyl plant. In particular, the West failed to provide the funds necessary to complete K2-R4. In a speech at the meeting on the opening of the Khmelnytska NPP in 2004 Ukrainian President Leonid Kuchma blamed the Western governments: "We have waited for five years, but the West evaded its obligations under various pretexts, laying down new requirements to Ukraine in return. And after obtaining the closure of Chernobyl it forgot about its promises for good"." (page 51)

In the USA some critic groups (such as the Union of Concerned Scientists) considered that the license-renewal process "was designed to limit the scope that could be considered, specifically the ability of the public to intervene" (Showcase), growing distrust among some social groups.

> According to Edwin Lyman, a senior scientist with the Union of Concerned Scientists, the license-renewal process itself risks public safety in that it "was designed to limit the scope that could be considered, specifically the ability of the public to intervene" by requiring stations to address "contentions" by showing the operator has a plan to correct a specific problem.(Thielman, 2016)
>
> (Showcase, p. 25)
>
> The GAO was critical of the NRC in the early 2000s for its monitoring and supervisory roles, although noted improvement. According to the GAO in 2006, the NRC improved its safety oversight functions. Between 2001 and 2006 it produced over 4,000 inspection findings for failure fully to comply with safe operating procedures, and the NRC subjected 79 of the 103 plants – 80%– to increased oversight for some time, and 5 plants to the highest level of oversight – due to the "more systematic nature of performance problems."(US GAO, 2006a: i)
>
> (Event 5, p. 51)

A.4.2. Governance issues

Other aspects related to governance and political relations between actors have been found in the SCR analysis. On the one hand, we observed political strategies that collide with one another and influence the NPP siting decisions. On the other hand, energy dependence and mutual international relationships are described in several of the SCRs.

a) Political games

Here we are selecting the SCR excerpts connecting actors' perceptions to the existence of some kind of political game that interferes with decision making processes, especially regarding NPP siting decisions.

- *Period 1950-1970*

In Finland, the history of nuclear energy is linked to strategic international political relationships of the country. So, it is said that Finland became member of the United Nations organization due to its participation in nuclear projects (General narrative). The diplomatic relationship with the Soviet Union conditioned some decisions on nuclear programs (Events 1, 2 and 5).

General Narrative:

"Finland had tried to become a member of the United Nations, but the Soviet Union had denied the access. Atoms for Peace – initiative was coordinated by the United Nations and therefore it could open doors for full membership." (page 17)

"Thirdly, Eisenhower's initiative called for international collaboration and this was exactly what the Finnish scientists, engineers and corporate managers needed after the war." (page18)

"As mentioned above, the Finnish energy policy aimed at higher degree of energy independency. This aim was pushed further because the imports of oil, coal and minerals connected Finland to the Soviet Union. Nobody knew how to break the tie. If Finland had purchased higher valued industrial goods from the Soviet Union, the imports of fossil fuels would have decreased. Unfortunately there were not enough high technology industrial goods that had any markets in Finland or outside Finland. This is why nuclear power reactors and steam turbines were very important." (page 21)

Event 1: From isolation into transnational networks

"The Finnish government founded a special committee to make necessary recommendations for the future energy production in Finland. Professor and the Nobel laureate A.I.Virtanen was expected to be the chairman of the committee, but Virtanen had criticized the Soviets and he was declared a persona non grata. His place was taken by Professor Erkki Laurila, an experienced scientist and engineer, who was a personal friend of the Prime Minister and soon-to-be President Urho Kekkonen. Laurila accepted the nomination but with one condition. He refused to lead "the Atomic Energy Committee', but instead "the Energy Committee". Laurila realized political and ideological tensions that were built in the Atoms for Peace program, and he did not want to tie his hands before the work had even started (Michelsen, Särkikoski 2005). (page 34)

Event 2: Finnish nuclear power project 1955-1962

"Erkki Laurila concluded that there was no need to rush into investing to heavily in nuclear power. Reactors were going to be developed, and prices would come down as manufacturing reaches the commercial level. Uranium chain had to be controlled and governed by the United Nations. Instead, Finland should spend wisely time before full-size nuclear power reactors would come to market. Finland needed research and training programs as well as networks with Western countries." (page 37)

"Other problems emerged in the late 1950s when the Soviet Union offered similar training programs for Finnish scientists and engineers. It became clear very quickly that the Soviets were not interested in educating Finnish scientists but in learning more about their experiences in the United States. Laurila understood the danger in this political game. His program was built on trust and if Americans would find out that tacit knowledge slipped from Finland into the Soviet Union, the Finnish training program would be closed. Laurila needed help from the West, and the best

and easiest way to educate the critical mass of nuclear engineers was to send them out to the world class research institutions." (page 38)

Event 5: Becoming the "Atom town"

"IVO had not yet closed the international bidding for the nuclear power project. The painfully slow evaluation was ongoing and behind the scenes nuclear companies and national governments lobbied to get their reactor offer accepted. (…)It was IVO's responsibility to end the bidding and announce the winner. With plenty of hesitation, the company decided to go for the AEG reactor. It was technologically most advanced and it promised the best economic results. But nuclear energy did not follow the fair game rules. For Finland, it was politically impossible to buy the first nuclear reactor from West Germany. Soviet Union would never accept such a decision. Even if the reactor would come from West Germany, IVO would never get enriched uranium from anywhere." (pages 49-50)

In Spain, in the early phases of nuclear development, the industry created its own rules by manoeuvring within the dictatorship and even ignoring the law in their dealings (General narrative). The lack of checks and balances in the dictatorship helped it and shaped the public image of the nuclear sector among the public for long time.

General narrative

In many cases, bid negotiations were well advanced before government pre-authorization was granted. The electricity companies often **ignored the law** in their dealings, and this attitude helped in increasing public opposition (page 15).

Spanish electrical utilities, mostly privately owned and organised as lobby, had working relations with the US multinationals since the 1920s and managed to **manoeuvre within the government** in order to play a dominant role in the ordering of nuclear power plants (page 8).

One of the main differences between Spain and the rest of Western Europe developing civil nuclear programs is precisely that the former was a conservative-authoritarian dictatorship (1939-1975 Franco's Regime) and the later democracies. As a working hypothesis we propose that this difference defined how decisions were made: in the Spanish case without any checks or balances. In fact, Spain was the only dictatorship among the early civil nuclear adopters in Western Europe (page 8).

In Sweden, the issue of nuclear weapons became a contested political issue for the receptors when the knowledge about the military aspects became more generally known. But at the political level people that were in favour of research on nuclear weapon also argued that this would act as a deterrent by showing the world that the country was capable to build it. On the other hand, the

public debate was somehow neutralized by the regulators and political parties due to the coming elections, reaffirming that this was a controversial issue for the political scene.

> *Event 1: The atomic weapons controversy*
>
> "The proponents argued that Sweden needed "tactical" nuclear weapons to effectively defend itself against an attack from the Soviet Union. They argued that the Soviet Union would use tactical nuclear weapons irrespective of if Sweden had such weapons or not, and that Sweden would be much more effective in its resistance if it also possessed such weapons. Thus the possession of such weapons would reduce the risk of an attack, as the cost for the attacker would be much higher. They demanded that research and development of nuclear weapons should continue and that the future Swedish reactors should be designed to produce weapons grade plutonium." (page 40).
>
> "The main purpose of the study group was to "neutralize" the nuclear weapons issue in the coming parliamentary elections in September 1960." (page 36)

- *Period 1970-1990*

According to the German SCR, the proximity of political elections was the main factor that influenced the government to postpone the choice of the place where a NPP should be built. (Event 2)

> *Event 4: Gorleben (repository site)*
>
> "With locating the repository site in the economically underdeveloped hinterland the government tried to avoid opposition against the project: *Reasons for the choice were political and economic, especially the closeness to the East German border and the low population density of the area.* As in the Wackersdorf case, they underestimated the protest potential of the local population." *(page 30)*.

In Spain, there are several examples of political games that created distrust among the public: sometimes a political party expressed its anti-nuclear principles but later, when governing, changed opinion and maintained or supported NPPs (Event 2); and the opposite happened between different territorial levels, even governed by the same political party, e.g. when the central government supported nuclear siting and the regional (autonomous) government stopped it (trying to increase its legitimacy by demonstrating sensitivity to social demands in the region) (Showcase).

Showcase: Valdecaballeros

Social and environmental movements denounced the unequal distribution of risk over the territory, and the fact that Valdecaballeros was chosen because it was a **disinherit village** and nobody cared if they host the "**worst** industry" (page 27).

Event 2: Ascó

"The village of Ascó lies in a predominately rural area based on agriculture. In contrast to other villages in the surroundings, Ascó had no touristic potential. The power plant was built when the area underwent a structural crisis in agriculture and the rural population increasingly migrated to the cities. The movement against the building of nuclear power plants started to rally in areas which were affected by the construction work. In this way, L'Ametlla de Mar and Ascó turned into the centres where the hard core of resistance against these installation took shape. As in another cases it was the property developers' strategy to hide the real reason for acquiring land in the municipality by pretending to build a "chocolate factory" until it was leaked that the real reason behind it was to build a nuclear power plant which to the people deep in the countryside did not mean much." (pages 38-39)

- *Period 1990-2015*

In the Bulgarian SCR the political fight between pro and anti-European parties conditioned the national nuclear agenda (Event 4). While pro-EU parties agreed with the shutdown and change of nuclear reactors, the anti-EU parties advocated keeping all of them. At political level, again the nuclear power discussion among regulators/promoters was used as an issue of how the country is positioning in the new membership for the EU. Specifically, on the issue of changing technology to other reactors (whether to keep old reactor or adapt them to new technologies). Bulgarian socialists wanted to keep all of the reactors with the argument of their strength and profitability. While Bulgarian democrats and pro-EU parties and officials were willing to compromise arguing that such step would be better for the Bulgarian country.

Event 4: Initial negotiations and contract with the European Union for memberships, which included decommissioning of reactor bodies 1,2,3,4 at Kozloduy NPP – 1993- 2004

"For Bulgarian socialists, the question was why Bulgarian reactors had to be decommissioned as condition for acceptance, while Slovakian and Lithuanian politicians used nuclear facilities as strategic objects in the same type of negotiations." (page 40)

In Spain there are cases in which a political change in the local and regional government halted the nuclear plans (Event 5). In these cases (such as those happened in the former period) the relevant issue is that policy makers changed their orientations and decisions towards concrete nuclear developments due to political strategies of the electoral arena, even contradicting themselves and their explicit political principles.

Event 5: NWR

"On 30 December 2011, the Council of Ministers designated the municipality of Villar de Cañas, a village of less than 500 inhabitants in the province of Cuenca, as the site for the ATC. The Socialists took power in the region on July 2015, ousting the conservative Popular Party, which rules at the national level. As of 2016, ATC works remain politically blocked and the firms are building their own storage at nuclear plant sites (El País, 26/12/2016)." (page 53)

The Catalan Parliament rejected the proposal of the nuclear waste repository in Catalonia in 3 occasions (page 55).

"According to the CANC (environmental movement), Villar de Cañas was obviously chosen for **political *reasons***; there was no technical reason to justify this piece of land: neither the quality of the place nor the proximity of nuclear facilities." (page 57).

b) Energy dependency

Several SCR bring out arguments about the key geostrategic role of energy in national industrial development and in political struggles in the international arena. In this sense, the debate about energy dependency becomes one of the key governance factors shaping public perceptions on nuclear issues. The strong influence of leader countries in a context of Cold War, as well as the technological colonization spread from some central scientific countries also played a role in conditioning these perceptions.

- *Period 1950-1970*

The Bulgarian SCR explains the country's vast dependency on the Soviet Union's technology and development model (Event 1).

Event 1: Starting the experimental reactor IRT-2000 NEAR SOFIA IN 1962

"The process of starting the functioning of the reactor it was the expansion of their **scientific and technological model**, on Soviet side. For Bulgaria it was announced as **sign of brotherhood and big scientific step (page 32).**

The Finnish SCR is full of references to the debate about national energy dependence and/or self-sufficiency. The whole nuclear program is justified from the beginning and during several decades as a key factor to ensure energy independency. The particular geostrategic position of the country during the Cold War, in-between East and West, facilitate the political preferences for an energy source that could guarantee a high degree of energy independence. The energy dependence from the Soviet Union is presented as a reiterate concern.

General Narrative:

"Massive investments in hydro, thermal and nuclear energy plants have been made during the past 70 years, but the goal of the energy policy is still out of reach. The latest estimation made by the Finnish government shows that even if all current energy projects are successful, Finland could cut the energy dependency to 50% by the end of this decade. Although it is widely accepted fact that Finland can never construct an energy system that is fully independent from foreign sources of electricity and fuels, high level of self-sufficiency is and has been the main goal of the energy policy. Because of this, nuclear energy has established a permanent position in the Finnish energy system." (page 5)

"Also it has been argued that new reactors are safe and they can improve the energy independency." (page16)

"This would require systematic investments in education of nuclear engineers and operators and ambitious research on nuclear sciences and technologies. Finnish energy policy aimed to improve the self-sufficiency in energy production and to limit the need to import fossil fuels and electricity from abroad (Michelsen – Särkikoski 2005). (…)Finland was able to maintain a high level of self-sufficiency and only 5% of the total consumption of electricity came from the imported resources." (page 18)

"Finland had signed bilateral trade agreements with Soviet Union in 1950 and the agreement guaranteed the imports of crude oil, coal and natural gas. The Energy Committee concluded that the first commercial nuclear power reactor could start in the beginning of the 1970s. Since then the economic growth and industrialization required new nuclear reactors almost annually." (page 18)

"Finland was not self-sufficient in energy production, hence contacts had to be built with the neighboring countries for imports of fossil fuels and electricity. One of the most important agreement was the bilateral trade agreement with the Soviet Union. Finland exported industrial and consumer goods to the East and imported oil, coal and minerals. Before the nuclear power stations were ready, almost half of the energy production in Finland was based on imported oil and coal. This arrangement resulted from the internal mechanism of the bilateral trade. When the Soviet markets grew, the exports of energy products to Finland also had to increase accordingly. This fueled industrialization and modernization process in Finland (Hirvensalo, Sutela 2017)." (page 20)

"Policy makers had their point view. Finland depended on foreign imports of fossil fuels and electricity, and in the future these dependencies should be eliminated. Finland had unused fossil fuels and hydro power resources, and several new nuclear power stations should be built in order to cover the growing demand." (page 24)

> "Meanwhile a new paradigm seemed to emerge. NOKIA mobile phones conquered the global markets, and the ICT-cluster developed new business opportunities. According to social scientists, Finland was moving rapidly away from the industrial society into post-industrial or knowledge society. Factories or nuclear power stations were no longer needed because high technology companies innovated sustainable energy sources. If more electricity was needed, it was purchased from the Scandinavian electricity markets or Russia, or Estonia. Self-sufficiency was no longer the central issue in the Finnish energy policy. Instead, it was a flexible and decentralized energy system that utilized smart grids, intelligent energy networks and energy saving (Kyllönen 2004)." (page 25)

In Sweden national independence of energy supply was an aspect of nuclear development subordinate to the competitiveness or reliability of the nuclear energy sector.

> *General narrative*
>
> "The Swedish power industry was made up of the State Power Board, called Vattenfall which produced about 40 % of all power and a dozen private power companies (many owned by municipalities and/or energy-intensive industries). For the power industry the national independence aspect of nuclear reactors was subordinate to their competitiveness and reliability." (page 10).

One of the arguments mentioned in the UK report related to the reduction of dependency on foreign energy sources (considered also more expensive). Nuclear energy offered a chance to reduce British reliance on coal and expensive imported oil amongst concerns of air pollution and a fuel crisis.

> *Event 2: First nuclear power station opens 1956*
>
> (...) Something reflected in the Queen's speech upon the plant: '…this new power, which has proved itself to be such a terrifying weapon of destruction, is harnessed for the first time for the common good of our community (page 33).

- *Period 1970-1990*

The Finnish SCR continues to give high importance to this argument. So, public authorities in Finland noted the country's dependency on energy imports and that the level of self-sufficiency had dropped since the early 1960s meanwhile the demand of energy continued to grow. The conclusion was that if no new nuclear power stations were built, self-sufficiency would go progressively down.

Event 6: First nuclear debates

"Nuclear debate continued until the end of the summer. The final word was given to industry advisor Leo Neuvo from the Ministry of Trade and Industry. He laid down the hard facts. Finland depended on energy imports and the level of self-sufficiency had dropped since the early 1960s. Meanwhile the demand of energy continued to grow almost 6% annually and there was no sign of levelling off. At this point Finland could supply only 28% of the total demand from her own domestic sources. If no new nuclear power stations were built, self-sufficiency would go down to 10% by 1990. Even if all the still unused energy sources were utilized, nuclear power was an option that would increase the level of self-sufficiency (Suomen riippuvuus… IU 28.9.1973)." (page 58)

- *Period 1990-2015*

In Bulgaria, the building of a new NPP (Event 5) reactivated the debate on energy (and political) dependency because it might help to diminish the energy imports from Romania and Turkey, while increasing dependency on Russian technology (Event 5).

Event 5: Referendum for constructing new atomic power plant in Bulgaria- 2013

Supporters for the construction of the new NPP argued that this would mean the **lack of dependency in buying electricity from Romania and Turkey**. While opponents claimed that it would increase the country's **energy dependence on Russia** as the Russian firm *Atomstroy export* was contracted to build the plant (page 27).

In Finland during last years there are some nuclear developments that would help to decrease energy imports (from Russia) and improve self-sufficiency, but due to unavoidable geopolitical decisions Finland became depended on Russian nuclear technology. (Showcase, p. 29-31)

Showcase: Collective memory and the uneasy nuclear collaboration between Finland and Russia/Soviet Union

"Russia's opinion on political, economic and also social issues must have been taken into account when Finland has decided her own stand. This has been very clear especially in energy policy. Russia is an energy superpower and most of its national income is based on production and export of various energy goods. As Steven Woehrel (2010) writes, the line between Russian energy policy and foreign policy is far from clear and many countries next to Russia are concerned that Moscow may use their energy dependency to interfere in their domestic affairs or to force them to make foreign policy concessions." (page 29)

"Finland depends and has depended on Russian energy source for more than a century. There are currently two transmission lines crossing the Finnish-Russian border and approximately one fifth of electricity consumption in Finland is covered by imports from Russia. Since the World War II Russia has been the biggest oil, gas and coal importer and

most of the enriched uranium comes also from Russia. According to Professor Veli-Pekka Tynkkynen (2015), the energy dependency from Russia is today more than 60% of the total energy production in Finland." (page 30)

"Therefore, it can be assumed that Fennovoima nuclear power station is going to produce the share of electricity that is currently imported from Russia. According to definition, this will decrease imports and improve self-sufficiency level. However, there will be another type of dependency. Rosatom will install the reactor, and most of the instrumentation comes from Russia. Therefore, although Fennovoima nuclear power plant cuts the need in importing electricity from Russia, Finland becomes depended on Russian nuclear technology." (page 31)

After Ukraine gained political independence, the perception of the Chernobyl NPP turned from being a sign of colonial domination by Russia into an important source of the electricity production that crucially contributed to the nation's economic survival and independence (Event 3). The public authorities hoped that nuclear power would ensure high degrees of independence from Russian oil and gas, but they had not been able to break free of this relationship because of heavy dependent on Russian nuclear services (as their nuclear development was linked to the former soviet model) (General narrative). In order to achieve a better public image, the Promoters of NPP tried to introduce rules of transparency and accessibility to the nuclear sites (Event 5).

General narrative

"Today, especially because of Russia's proxy war in eastern Ukraine and annexation of Crimea in 2014, many in Ukraine see nuclear power as a way to achieve energy independence from Russian oil and gas. However, the country also relies on Russia for nuclear fuel and technology for Ukraine's Soviet-designed reactors. Only recently it turned to the EU and western corporations to supply fuel and technology." (page 4)

"As this report indicates, Ukraine's nuclear industry is determined to build on the Soviet heritage by extending the licenses of existing reactors and building new reactors. As part of a government strategy to lessen dependence on Russia for energy needs, most notably gas, industry and government are seeking to meet the needs for nuclear fuel by developing Ukraine's uranium, zirconium, and other capacities, and also by buying fuel from abroad, notably from Westinghouse, rather than relying on Russia exclusively for fuel and spent fuel handling and nuclear technology." (page 5)

Event 3: Vote on the repeal of the moratorium and relatively weak anti-nuclear protests (1993-1994)

"When Ukraine gained its independence in 1991 attitudes towards nuclear power changed and the country embarked on policies to preserve nuclear power generation capacity." (page 45).

"After the dissolution of the Soviet Union, public attitudes toward nuclear power changed dramatically. The nationalist dimensions of anti-nuclear protests lost their importance in the public arena after the Ukraine became an independent nation. The Ukrainian people began to see Chernobyl less as a site of colonial domination by Russia and instead as an

important source of the electricity production that contributed to the nation's economic survival and independence, including from Russia itself. The hard bargaining by the Ukrainian authorities with European countries and organizations over the closure of the Chernobyl NPP in late 1990s-early 2000s (see Event 4) indicates how important its continued operation was for the country." (pages 46-47)

Event 5: Start-up of the Kmelnytska 2-Rivne 4 nuclear reactors (2004) as part of strategy aiming at "nuclear revival" and new public information effort

"Public communication also emphasized the way nuclear technology is important for national prosperity and independence and that nuclear installations operate in harmony with human activity and natural environment." (page 55).

In the USA, supporters of nuclear energy emphasize the facts that nuclear power will help secure US energy independence (General narrative). However, in the early 1990s the United States and Russia reached a landmark agreement that would turn former Soviet nuclear weapons material into fuel to power America's civilian nuclear reactors. The "Megatons to Megawatts" partnership provided enough fuel to generate 10% of America's electricity needs (Appendix 4), and it could be interpreted as a way of losing energetic autonomy.

Generally speaking, supporters of nuclear energy emphasize the facts that nuclear power will help secure US energy independence; (…) and is crucial to provide base load for energy demand into the 21st century. They argue that NPPs operate as intended.

(General narrative, p. 17)

The only US facility that enriches uranium in 2016, USEC, in Eunice, NM, has struggled with bankruptcy pressures, so that uranium enrichment, pioneered in the US, "may become primarily a European and Russian technology."(Wald, 2014) Currently, almost all the uranium used in US commercial reactors is imported. After reaching a peak in 1980, domestic mining now accounts for only 10% of the fuel used in US reactors.

(Appendix 4, p. 82)

In November 2013 the DOE announced that it had selected a proposal from Global Laser Enrichment (GLE) to build a plant to enrich uranium. In the same announcement, the DoE said it would enter negotiations with Areva to process off-specification uranium hexafluoride as blend stock for domestic nuclear fuel. This would be carried out using Areva's existing nuclear fuel fabrication facility in Richland, Washington. DOE said that the GLE and Areva projects represented "an important next step" in planning for potential future uses and clean-up efforts at Paducah as well as

reducing the costs to the taxpayer of the clean-up operation

(Appendix 4, p. 83)

"In the early 1990s, the United States and Russia reached a landmark agreement that would turn former Soviet nuclear weapons material into fuel to power America's civilian nuclear reactors. The company played a key role in implementing the deal, marketing the downblended material to U.S. utilities and arranging for deliveries. From 1993 to 2013, the "Megatons to Megawatts" partnership provided enough fuel to generate 10% of America's electricity needs. It was the most successful non-proliferation effort in history – eliminating more than 20,000 warheads worth of weapons-grade material.

(Appendix 4, p. 83-84)

B. Public engagement in the selected case studies

Based on the flow of information between participants and promoters, i.e. those who have commissioned a particular engagement initiative, we have differentiated between three engagement types: Public communication; Public consultation; and Public participation. In addition, we suggest designating engagement actions initiated by the public and directed towards the regulators or nuclear companies as 'public-initiated engagement'.

B.1. Public communication

Public communication refers to a process where information is transferred from the sponsor of an initiative to the public without any feedback being sought. Here we include several modalities of one-way communication, ranging from the absence of communication to actors' communication through diverse tactics and channels. Different ways of *'public initiated engagement'* are also identified and described through examples from the SCRs.

B.1.1. Selective Communication / Secrecy

Some SCRs describe cases of absence of communication, where information about nuclear issues was top secret or was disseminated only among a few people (elites) and hidden to the main population.

- *Period 1950-1970*

According to the Finnish SCR, decision making on nuclear projects in Finland had been made for long time by a small group of politicians, engineers and corporate managers. Therefore, it was managed and governed by politically, socially and technically superior individuals (General narrative). However, we should take into account that at the same time there was a true interest for knowing the public opinions. So public opinion surveys had been used to get knowledge about public attitudes towards nuclear energy in general, or towards the sitting of a NPP

General Narrative:

> "Laurila also emphasized political and ideological aspects of nuclear power. Finland, which is located between East and West and "squeezed" between two hostile superpowers, was unable to make independent decisions concerning nuclear energy. Therefore, nuclear energy in Finland could never be a "democratic" decision. Instead, it was managed and governed by politically, socially and technically superior individuals. (…)The latest historical research confirms Laurila's interpretation at least partially, but argues that the picture has more colors. Indeed, the nuclear history in Finland was shaped by a small group of politicians, engineers and corporate managers who exercised what Gabrielle Hecht has called "technopolitics" (Hecht 2009)." (page 9)
>
> "Nuclear energy represents a centralized energy production and an authoritarian technology. Future energy systems are decentralized, intelligent and flexible. (Lovio 2017)." (page 14)

According to the USA report, the accident of the Enrico Fermi Atomic Power Plant, Unit 1, was kept secret at the time (1966) (Event 1). Besides, through less-than-opaque review procedures and secrecy, the AEC (regulator) kept its review of safety and other issues out of public scrutiny.

> The Enrico Fermi Atomic Power Plant, Unit 1, located in Monroe County, Michigan, near Detroit, was an LFMBR (liquid metal fast breeder reactor, cooled by sodium), designed for 430 MW, although the maximum reactor power with the first core loading was 200 MW. It suffered a meltdown in 1966 that made the reactor inoperable and endangered millions of people. The accident was kept secret at the time.
>
> (Event 1, p. 28)
>
> Detroit Edison formed the Power Reactor Development Company (PRDC) to move Fermi ahead. In the late 1950s the United Auto Workers brought suit to halt construction because of safety concerns, and lost eventually in the US Supreme Court, 7-2. Other public concern was limited by AEC secrecy. (US SC, 1961)
>
> (Event 1, p. 29)
>
> Through less-than-opaque review procedures and secrecy, the AEC kept its review of safety and other issues out of public scrutiny.
>
> (Event 1, p. 29)

- *Period 1970-1990*

In early times in Bulgaria there was an agreement with the Soviet Union to maintain secrets about technical nuclear information (Event 2), and later information flowed but only among selected

people. When the Chernobyl accident happened the government did not inform the population about its real scale and consequences, nor about the accident in general nor about specific safety measures that the affected population should have taken, and in this case also information flow was mainly provided at close people to the government (Event 3). The media did not report the accident, until a year later a TV documentary mentioned the accident and the population became aware of its importance. (Event 3)

Event 2: Starting the NPP Kozloduy and the Vrancea earthquake – 1974-1977

"The agreement between Soviet Union and Bulgarian authorities also specified the **secrecy** of technical information: none of the organizations involved was to reveal the provided documentation to entities or organizations of other countries." (page 32)

Event 3: Reaction of the Green movement to the Chernobyl accident

The Bulgarian communist government did not inform the population on 26 of April 1986 when a serious accident happened on the Ukrainian nuclear power plant Chernobyl. **Information flow was mainly provided at close people to the government** and yet they take actions to secure their families. Only the people close to the party nomenclature knew the seriousness of the situation and ordered special supplies, clean from radiation pollution, for them and their families. Army forces were also protected by the officials (page 37).

When the accident occurred, the Bulgarian communist government did not inform their population about the real scale and consequences of the accident and the national media remained quiet, saying only that there is no serious danger after the accident. Three years later in the end of 1989, the Bulgarian communist regime collapsed. The Green organization – Ekoglasnot, with no pure political aims acted as catalyser of receptors' concerns on nuclear power, demanded **mainly information about the environmental pollution** caused by big technological projects and by the Chernobyl accident. One of the main questions remained about what were the consequences of Chernobyl accident. (page 38).

The general public awaking happened in late 1987, when a **short documentary** by the journalist Jurii Zhirov find its place on a national television broadcasting which was not even about Chernobyl or other nuclear issues, but mentioned it slightly (page 38).

According to the Spanish SCR, in the case of the nuclear moratorium (Event 4) the government seemed to disregard any strategy for communicating to the public. The communication flows between the government and the stakeholders were hidden to the public and instead developed through private initiatives and channels. For example, the government disregarded any communication strategy for explaining the moratorium to the public, the media would inform

without guidance from the government, and neither antinuclear movements nor local populations were consulted about the moratorium according to sources at both ends.

> *Event 4: Nuclear moratorium*
>
> "There were many private meetings between the government delegates and the electric utilities and the banks (national and international). None of that discussion transcended. The government disregarded any communication strategy for explaining the moratorium to the public. The media would inform without guidance from the government. Unlike the electricity firms, the nuclear industry was never involved in the discussions with the government about their fate regarding the moratorium and looked for eventual compensation through their contracts with project owners. (…)Neither antinuclear movements nor local populations were consulted about the moratorium according to sources at both ends, our interviews and, the available evidence." *(page 52)*

In Ukraine the information about the Chernobyl disaster existed but was mainly restricted to optimistic messages about management control and heroic soldiers and firemen's efforts (Showcase). By 1988, it was very difficult for the regulators to keep concealing information on the disaster's impact and its mismanagement by the government. Regarding how regulators managed information, the receptors perceived a lack of flow of information to act adequately in an emergence status. The reality of the situation falsified, by the persistent narrative provided by regulators of the successful management of the consequences from the accident for a number of years after in the state controlled media, asserting the reality of life returning to normal and no grounds for concern, and instead focussing on stories of the heroism of emergency workers against a depicted radioactive monster. In some way the reality of the situation was falsified by the narrative provided by public authorities (promoters / regulators). In this case the lack of communication was not on the accident itself but about its serious consequences (Event 1). The liberalization of the second half of the 1980s and revelations about the true scale of the Chernobyl disaster fuelled anti-nuclear, environmental, and nationalist movements that sometimes overlapped.

> *Showcase: Dealing with Chernobyl disaster aftermath*
>
> "By the end of 1988, it had become increasingly difficult for Soviet federal and republican authorities to conceal information on both the impact of the Chernobyl disaster and its mismanagement by the Soviet state. This situation related not only to the extreme gravity of radioactive contamination, but also to the progressive liberalisation of the Soviet political regime. The latter unfolded with glasnost and perestroika, introduced by Mikhail Gorbachev in 1985, and

led to freer circulation of information, weakening of censorship and the Communist Party's control over society, more possibilities for public expression of political and social discontent, and pluralisation of political life." (pages 38-39)

Event 1: Chernobyl disaster (April 26, 1986)

"Between May 1986 and the beginning of 1989 the official optimistic narrative about successful "liquidation" of the accident's consequences and the return to a normal life remained dominant in the Soviet media. The information about the scale of the accident and the danger of its consequences was replaced by a vivid account of a heroic battle of emergency workers (the so-called liquidators) against what was painted as a radioactive monster, with some living creature features, an atom that went out of control or an external enemy. The press, radio, and television that were totally under the control of the State and the Communist Party described the solidarity of the Soviet people facing the disaster as one united family and the efficiency of the central and local authorities in dealing with everyday problems related to evacuation, health control, cleaning-up operations (Kasperski: 110-128, Montaubrie 1996)." (page 35)

- *Period 1990-2015*

No mention of this dimension in the SCRs for this period.

B.1.2. Direct actors' communication through the media and other channels

The actors used several means and channels to disseminate their news and viewpoints on nuclear issues, trying to influence the other actors' views. Sometimes the actors used traditional media (newspapers, radio, and TV) and new Internet media (websites, social media). Other times they tried to spread information directly to the public by themselves, using several communicative strategies.

- *Period 1950-1970*

In the UK a series of government films were published presenting nuclear energy as somewhat necessary for the country's future and showing that Britain was ready to lead the scientific and political world (Events 1 and 2). A serious incident (Windscale 1957) challenged the media approach and information about it was heavily restricted and controlled by the government.

Event 1: First nuclear weapons test 1952

"Part of a series of government films, this was the first major description of the British nuclear weapons programme, and the first publication of the reasoning for the programme on a nation-wide scale by the UKAEA and distributed by COI." (page 32).

Event 2: First nuclear power station opens 1956

"Part of a series of government films, this was the first major description of the British nuclear energy programme, presenting nuclear energy as clean, safe, and necessary. The film highlights Britain's achievements in constructing the first full-scale nuclear power station, and in other peaceful uses (such as isotope production)." (page 34).

"As with the first British nuclear bomb test press coverage of the opening of Calder Hall was overwhelmingly positive.(Jay et al., 1954; Welsh and Wynne, 2013) For many, nuclear power was the 'good' face of nuclear power, something reflected in the Queen's speech upon the plant." (page 33).

Event 3: Windscale Fire 1957

"Public information about the fire was heavily restricted and controlled by the government. There was intense **newspaper coverage** of the events; however, this was dependent on the release of information from government." (page 37).

In the USA, regulators and public authorities made during the 50's and 60's a long series of films about nuclear energy, which were seen by millions of people.

Spencer Weart points out that in mid-1960s American agencies and corporations made twice as many films about reactors and three times as many about safety and environment as in the preceding five years. In the 1960s roughly 40 million people attended AEC film screenings and many times more on TV. Weart writes, "The result was less to excite the public about AE than calm them. The films toned down the utopian promises of 1950s films," focusing on electrical energy rather than on "medical and agricultural fantasies."(Weart, 1988: 299) Among the AEC films of the 1950s included "Power and Promise: The Story Of Shippingport Nuclear Power Plant,"1 "Nuclear Energy Goes Rural," "Atomic Venture," "Atomic Power Today: Service with Safety."

(General narrative, p. 18)

- *Period 1970-1990*

According to the Spanish SCR, classic mass media (newspapers, TV and radio) had been used to announce the intentions of Promoters and Regulators of NPPs. Whilst national media was available to them, most of the Receptors instead had only access to local press to launch their mesagges. Sometime national newspapers where used by public authorities of different territorial

levels, but local receptors felt useless during the decision process because the location of the nuclear central power "came from above" (Showcase). In any case, little information was spread by press at the early stages of nuclear development in Spain, although after the Vandellós I incident (1989) the Promoters began producing periodical news about the decommissioning process, which had also been in some degree publicised and informed through the website (Event 1). In some cases the Promoters held press conferences to present NPP construction projects, and announced in the press the NPP's entry into operation as a way of making the population aware of the irreversibility of the NPP (Event 2). Other times the nuclear industry paid for full pages in the newspapers and made declarations in TV and radio reclaiming the need to restore the original nuclear plans (Event 4).

General narrative

"Official information, both from the JEN during its existence, and the Nuclear Safety Council thereafter, as well as the Ministry of Industry, appeared in the Official State Gazette (BOE), in the form of laws, decrees, ministerial orders and instructions and inspection records of the JEN." (page 30).

"The public voice could also be heard, especially in regions where building nuclear power plants had already commenced, and local press coverage brought lobbying by stakeholder groups into the public's eye." (page 16).

Showcase: Valdecaballeros NPP (built but never operative reactor)

"Few efforts in communication activities seem to have taken place. As the Valdecaballeros mayor said: "We were cheated vilely, they put the nuclear power plant without asking our opinion, and they took away in the same way, without considering the people living in the territory ." (page 32).

"The mayors of Valdecaballeros and Castillblanco (a neighbouring village) expressed their feeling of uselessness during the decision process because the location of the nuclear central power was only political (not technical) and it "came from above." (pag 26).

Event 1: Vandellós I (nuclear incident in 1989)

"The communication policy of the decommissioning company (ENRESA) was quite different of that of the company operating the plant (HIFRENSA). In an interview to the newspaper El Mundo (2003), the director of the decommissioning NPP highlighted the knowledge and technical experience gained at the decommissioning of Vandellós I, guarantying the high reliability and safety levels, generating international benchmarks for decommissioning nuclear power plants." (page 36-37)

Event 2: Ascó Nuclear Power Plant

"At a press conference in February 1970, FECSA (Fuerzas Eléctricas de Cataluña SA – Electric Power of Catalonia Ltd.) published their project beginning of the construction in 1971 (before asking for the permission of the municipality)."

(page 38).

Event 4: Nuclear moratorium:

"Unlike the electricity firms, the nuclear industry was never involved in the discussions with the government about their fate regarding the moratorium and looked for eventual compensation through their contracts with project owners. But it paid for full pages in the newspapers claiming the disastrous effects of the moratorium on employment and the industrial development of the country." (page 52)

"Between 1984 and 1994 the electricity companies and the nuclear industry privately attempted to have the government to revise the moratorium. Declarations in newspapers, TV and radio reclaimed the need to restore the original nuclear plans." (page 53).

In Sweden, to cope with the Chernobyl impact on public opinion, the regulators organised and participated in numerous communication activities through the media trying to calm the general public. (Event 4).

Event 4: Chernobyl and its effects in Sweden

"The Radiation Protection Agency, SSI organised and participated in numerous communication activities as a reaction in order to calm the general public, i.e. appeared on the TV news almost every evening for a couple of weeks." (page 49).

"Mass media were again filled with articles concerning the pros and cons of nuclear power." (page 50).

In the UK the public authorities implemented an intensive advertising campaign in newspapers about alternative reactor types with the aim of generating (supposedly) public confidence (Event 4). In the 70s, a report from the Royal Commission on Environmental Pollution was published (Event 5) bringing the problem of nuclear waste to a wider public audience.

Event 4: SGHWR chosen as AGR replacement 1974

"Westinghouse and Atomic Energy of Canada (amongst others) advertised their PWR, BWR and CANDU systems in national newspapers, highlighting their safety, economy and reliability – hoping to influence the public debate surrounding the choice." (page 40).

Event 5: Royal Commission on Environmental Pollution 1976

"Publication of the report began public debate in the UK over longer-term solutions for nuclear waste, and gave legitimacy to groups using this issue to attack continued deployment of nuclear power." (page 44).

In Ukraine a variety of 'information units' were established in many territories after the Chernobyl accident providing information about levels of radioactivity and educating the public on nuclear technology in a broad sense (Event 2), thus, the regulators were making constant press-releases.

> *Event 2: Post-Chernobyl anti-nuclear protests and vote on the moratorium on the construction of the new nuclear reactors (1989-1991)*
>
> "Thus, to overcome the negative consequences of secrecy and distrust, many experts proposed informational and educational work with the public. Like the partisans of the "public understanding of science" ideas in the '70s in western countries, they believed that to restore the prestige of nuclear science and technology and overcome people's fears they needed to produce a better informed public. For that matter, information units were established at many stations that produced, for example, short press releases about the levels of radioactivity in the surrounding environment, important events at the plant, and educational material about nuclear power and radioactivity. Some also started organizing the excursions to the station for the general public. Also, the All-Union Nuclear Society as well as the Ukrainian Nuclear Society were created in 1989 and 1992, respectively, with one of their goals to educate general public about the benefits of nuclear technologies. Nuclear information centres have spread throughout Russia and Ukraine, especially in the first decade of the twenty-first century." (page 43).

In the USA the message that nuclear power represents progress has been deployed by images, meanings and messages set forth in TV, newspapers and journals, cartoons, and opinion columns. (General narrative, p. 17-19)

> According to one analysis, several images frame attitudes toward nuclear power. A prevailing view among proponents suggests that nuclear energy represents progress with its promise of clean energy, efficiency and "technofixes" with their implicit rejection of Luddism. An opposing position finds that nuclear technology leads to the destruction or disruption of nature. This framing plays out in media which are crucial in the construction of public understandings with their images, meanings and messages set forth in TV, newspapers and journals, cartoons, opinion columns.(Gamson, Modigliani. 1989)
>
> (General narrative, p. 17)
>
> The authors conclude that media discourse provides "an essential context for understanding the formation of public opinion on nuclear power. More specifically, it helps to account for such survey results as the decline in support for nuclear power before Three Mile Island, a rebound after a burst of media publicity has died out, the gap between general support for nuclear power and support for a plant in one's own community, and the changed relationship of

age to support for nuclear power from 1950 to the present."(p. 1)

(General narrative, p. 18-19)

- *Period 1990-2015*

In Spain the public authorities published reports on the decision about the siting of the nuclear waste repository in a special website (Event 5).

Event 5::NWR

A study was carried out and published saying that radiation emitted by nature is higher than the ones from NPP. Results from the study were published on **press.** The National Government published a report on the decision about the sitting of the repository in a **website** created on purpose: www.emplazamientoatc.es. Actors pro and against the NWR sitting made a wide use of **Twitter** and **website** resources. (page 58)

In Ukraine environmental activists illustrated the supposed lack of safety of nuclear installations by putting out constant press-releases.

Event 3: Vote on the repeal of the moratorium and relatively weak anti-nuclear protests (1993-1994)

"(Environmental activists) They illustrated the lack of safety of Ukrainian nuclear installations by putting out constant press-releases on various incidents that could one day become another Chernobyl." (page 47).

B.1.3. Visitors' information centres

In the SCRs there are some references to visitors' information centres as a way of better communicating and promoting transparency on nuclear issues. These centres are managed by the promoters of NPPs, usually in the same plant installations or nearby. In the case of Sweden, research centres were promoted to help in disseminating nuclear understanding among general people.

- *Period 1950-1970*

In the F.R. Germany the promotion of "research centres" on nuclear issues had been part of the communicative efforts to make technology more acceptable (even among its potential promoters). But it is said that the plan to promote research to generate arguments against critics of nuclear energy worked only in part. (General narrative)

General narrative
"In an effort to make a case against critics of the nuclear energy industry, the German government established major research centers in Karlsruhe and Jülich in 1956 and 1962 that soon became influential in European nuclear research and development. The plan to promote research to generate arguments against critics of nuclear energy worked only in part. This time, opposition came from civil society, especially women. Local women's associations in Karlsruhe were critical of the research centers because of the danger posed to citizens in a city with a high population density." (page 8).

- *Period 1970-1990*

No mention of this dimension in the SCRs for this period.

- *Period 1990-2015*

In Spain, since 2009, the Promoters enabled a part of some NPP in a visitors centre trying to reach a more interactive communication approach. (Event 2).

Event 2: Ascó
"In 2011 the information centre at the NPP was renovated. For the companies running the plant, this new equipment, designed as an interactive space for the dissemination of energy and the operation of a nuclear power plant "responds to the multiple objective of meeting the existing demand for visits to the plant and at the same time generating added value That complements the offer of attraction of visitors of the region of the Ribera d'Ebre ". (page 43)

In Ukraine, Promoters put in a lot of effort to improve awareness of nuclear activities, to inform local populations about the operation of nuclear reactors, and to explain why national atomic industry was safe, open, economically beneficent and important to insure national sovereignty and prosperity (Event 5). But the persistent lack of financing hindered efforts significantly. While the information centres expanded and developed new infrastructure and exhibitions, much of this

came from local initiatives without common communication strategies directed to outside communities. One interesting communicative activity is that of children drawing contests on nuclear themes. The information centres of each of 4 operating Ukrainian power stations announce artistic competition every year. Children living within 30 and up to 100 kilometres diameter zones are encouraged to send their works. The drawings seem to circulate quite widely.

Event 5: Start-up of the Kmelnytska 2-Rivne 4 nuclear reactors (2004) as part of strategy aiming at "nuclear revival" and new public information effort

"The renewed public relations effort has aimed at promoting the atomic industry as safe and open to the public, economically beneficial for local communities and the whole nation, and different from "Soviet" nuclear technology with its secrecy and such accidents as Chernobyl. "Public communication also emphasized the way nuclear technology is important for national prosperity and independence and that nuclear installations operate in harmony with human activity and natural environment." (page 55-56).

"Children drawing contests on nuclear themes are a good example of the contemporary nuclear communication effort as well as of cultural representations of the nuclear energy in Ukraine. Already in the early 1990s nuclear specialists in professional societies in Ukraine advanced the idea of working with children's drawings to engage both younger and older audiences, and the information centres have embraced them fully. They see children as potential future young cadres for nuclear industry and as easier to engage than adults. It is also possible to reach adults through children (Barbashev 2015).

Drawing competitions on nuclear themes were introduced through local initiative at some plants early on. They became particularly popular in the late 2000s and are now coordinated by the nuclear operator Energoatom. The information centres of each of 4 operating Ukrainian power stations announce artistic competition every year. Children living within 30- and up to 100 kilometres diameter zones are encouraged to send their works to the information centres of the plants, which then select several of them to participate in the second round at the national level. Children submit drawings and sometimes handicrafts or animation movies. The number of participants may vary but often reach one hundred or more in these contests. The best works are usually rewarded with material prizes.

The contests are very much local initiatives and rely on the enthusiasm of local teachers and information centers workers who are also very often former teachers or have worked in secondary education. They are also local as a celebration of local communities whose lives revolve around power stations.

At the same time the drawings seem to circulate quite widely: present on the walls of information centers, on official web-pages and social media and in printed publications of nuclear organizations. They are even offered as presents to some foreign guests of the nuclear operator Energoatom. As a consequence they also contribute to standardize visual representations of nuclear power. From year to year drawings repeat some of the same themes or even copy the drawings from previous years the children can find on the internet or displayed in the information centers." (pages 54-55)

"However, constant changes in the direction of the industry, new appointments at the head of Energoatom, and

different communication teams coming to power has meant the absence of common methods or approaches in the effort at public outreach. Thus, for example, Ilona Zaets, the chief of the PR and communication in 2016, came into the office with the new president of Energoatom, Iurii Nedashkovskii, who was appointed in the early 2014 after the political crises in Ukraine in 2013 and 2014 and the flight of former Ukrainian President Yanukovich from office in February 2014 (Zaets 2014, 2016). A persistent lack of financing has also nagged efforts significantly. While the information centres expanded and acquired new buildings and exhibitions, much of this came from local initiatives and often without common communication strategies directed to the outside communities.." (page 54).

B.2. Public Consultation

Public consultation refers to a process of conveying information from members of the public to the sponsors of the initiative, following a process initiated by the sponsor (Rowe & Frewer 2005). In this process, there is no formal dialogue between individual members of the public and the sponsors. The analysis of the SCRs allowed the identification of several types of consultation method, such as surveys (opinion polls), some consultative referendums and different kinds of informative meetings and public debates.

B.2.1. Surveys and opinion polls

Some forms of consultation seek to know the opinion of large population samples on a specific topic (the location of a repository, the suitability of a moratorium, etc.).

- *Period 1950-1970*

In Finland, public opinion surveys had been used to get knowledge about public attitudes towards nuclear energy in general, or towards the sitting of a NPP in a concrete territory. (Event 5)

General Narrative:

"Nuclear energy is still one of the cornerstones in the Finnish energy policy. Moreover, nuclear energy is also supported by majority of Finnish people. According to current surveys, about 45% of Finns favor nuclear energy, and only about 25% vote against it." (page 26)

Event 5:

> "Even if no more reactors will be built on Hästholmen, the town will still be remembered as the first atom town in Finland. Public perception to nuclear energy in Loviisa has remained surprisingly positive throughout the last 50 years. Latest surveys show that vast majority of the members of the town council would welcome a new reactor any day. Those who oppose nuclear energy, usually support alternative energy source. Today there is a plan to build a large windmill park right next to Hästholmen (Rosenberg 2004)." (page 52)

In the USA, poll surveys on public opinion about nuclear energy were already done in the 50's (showing a large majority of people having no fear of having a plant located in their community). (General narrative)

> One poll published before 1962 (in 1956) showed 69% of Americans had no fear of having a plant located in their community.(Erskine, 1963)
>
> (General narrative, p.18)

- *Period 1970-1990*

In Spain quite a number of public opinion polls have been found (at the national and the local level) since 1978 (not before), but with little consistency in terms of the survey design therefore limiting the possibilities for longitudinal analysis.

> *General Narrative:*
>
> "Opinion polls can provide useful insights on public attitudes towards nuclear energy and its changes (if any) through time, both at the national and at the local level. Notably, although quite a number of public opinion polls have been found (at the national and the local level) there is little consistency in terms of the survey design, its specific objectives, and the sampling. Thus, the polls have addressed a quite wide range of diverse nuclear related issues in different historical moments, so there are strong limitations in terms of historical and comparable data or longitudinal analysis. Even though, the available evidence does provide a useful overview of the Spaniards opinion' towards nuclear.
>
> (…)

Opinion surveys were used in Sweden to gain knowledge of public attitudes towards nuclear power after the Chernobyl accident. (Event 4)

> *Event 4: Chernobyl and its effects in Sweden*

Mass-media gave generous coverage to the increased radiation levels, and this caused much anxiety (page 21). Also, the **poll institutes** registered a large increase of negative attitudes to nuclear power (page 49).

Opinions surveys were conducted in the UK to find the degree of public support for new nuclear plants. (Event 5)

Event 5: Royal Commission on Environmental Pollution 1976

"A public **opinion survey** conducted in 1977 found that whilst a majority of the public were in favour of the construction of nuclear plants (49% to 32%), this dropped to a tie (43%, with fewer 'don't knows') when the interviewee was first asked to consider the problem of nuclear waste." (page 42).

In Ukraine post-Chernobyl surveys about public attitudes towards nuclear power had been also used in order to better understand the protests and the moratorium vote trends (Event 2). The public authorities tried to keep the protest movement under surveillance, and, unsuccessfully, to control and limit its scope.

Event 2: Post-Chernobyl anti-nuclear protests and vote on the moratorium on the construction of the new nuclear reactors (1989-1991)

"An important **survey of public opinion** was conducted in 1990 by the Soviet Academy of Sciences and the All-Union Center for the Study of Public Opinion on the attitudes of the people towards nuclear power. It focused on the population around several nuclear power plants in the Soviet Union (in Ukraine it was the case of the Khmelnytska NPP). The results showed a rather even split of the population in favour and against the development of the nuclear power (up to 40% in each case). **Another opinion poll**, ordered by the Soviet Ministry of Atomic Energy, was conducted in 1991. It included the population around Zaporizhzhya and South-Ukrainian power plants, where up to 80% of residents of the 30km zone around NPPs were against the continued operation of the plants." (page 42-43).

"State and party officials tried to keep the **protest movement under surveillanc**e, and, unsuccessfully, to control and limit its scope." (page 42).

"To remediate the public distrust towards nuclear power one needs to produce a better informed and educated public (page 44).

"Another opinion poll, ordered by the Soviet Ministry of Atomic Energy, was conducted in 1991. It included the population around Zaporizhzhya and South Ukraine stations where up to 80% of residents in the 30km zone around the NPPs were against their continued operation (Gedroits 1991; Tsentr obshchestvennoi informatsii 1991a). The sociologists also claimed to identify a negative link between levels of education and what respondents knew about nuclear power and the fears they expressed with regard to its development." (page 42-43)

According to the USA report, surveys testing the public opinion towards nuclear energy had been reported several times in the SCR. (General narrative, p. 11, 19-20).

> Further, in the 1970s, as more and more experts and groups entered controversies over nuclear power, citing, safety and so on, the public grew restive and confused, and this contributed to the decline of nuclear power by effectively tarnishing the reputation of experts.(Balogh, 1991) Balogh concludes that government officials must open the policy-making process fully in the early stages and "test for demand rather than seek to create it artificially"(Balogh, 1991: 326).
>
> (General narrative, p. 11)
>
> In 1984 OTA published Nuclear Power in an Age of Uncertainty that considered "Public Attitudes Toward Nuclear Power." The study noted that "public attitudes toward nuclear power have become increasingly negative over the past two decades, with the most recent polls indicating that a slight majority of Americans opposes further construction of reactors." In the 1950s pollsters hardly studied the issue, while in the 1960s several opinion polls noted that less than a quarter of the public opposed nuclear power.
>
> (General narrative, p.19)
>
> The accident at TMI led to a sudden decease in the percentage of people who had been in favor of or uncertain about continued construction of reactors, with the percentage opposed increasing. Polls since mid-1982 indicated a slow erosion in support for nuclear power with over 50 percent opposed, and a large majority opposed construction of new plants in or near their communities. Nuclear was even less appealing than offshore oil drilling and coal plants, nuclear is now the least favored alternative. In spite of a majority finding nuclear power as potentially unsafe, many people saw it as a solution to the country's long-term energy problems, and the majority rejected a halt to new construction or a permanent shutdown of all operating reactors. (OTA, 1984: chapter 8)
>
> (General narrative, p. 19-20)

- *Period 1990-2015*

In Bulgaria a research consultation sponsored by the public authorities and carried out by a social sciences firm was used to decide how to proceed with the nuclear sector when joining the European Union (Event 4).

> *Event 4: Initial negotiations and contract with the European Union for memberships – 1993- 2004*

A sociological agency MBMD conducted a **research consultation** about the invitation from the European Union for membership included a question about to what extent population with the statement: *Membership in EU needs sacrifices and privations now, but its worth for the future?*" (results were 23,9% fully agree, 34,7 rather agree, 15,8 rather disagree, 11,4% totally disagree, 14,2% without answer). In this period Bulgarian society sees the EU membership as better opportunity than keeping the nuclear industry in its former scale (page 41).

The Spanish SCR describes the nature and evolution of the topics of interest for the institutions commissioning knowledge on public opinion. (risk perception starts to be important since the 90's, environmental benefits arise as a topic also by 1997, etc.) (General narrative, p. 58-59).

General Narrative:

The nature and the evolution of the topics of interest for the institutions commissioning social research on nuclear energy in Spain can also provide insights in terms of the issues in the public arena. For instance, it is worth mentioning that during the first years most surveys dealt with the understanding and perception of radiation issues. NIMBY (Not in My Backyard) does not emerge as a topic until 1990; risk perception becomes crucial from 1993 (including the perception of both health and environmental risks); support to research in nuclear energy and the related investment is first addressed until 1997; environmental benefits arise as a topic also by 1997, etc." (pages 58-59)

A public opinion survey was done in Ukraine to know the support of people to a NPP project.

Event 4: Controversial negotiations on the closure of the Chernobyl NPP and public hearings on the completion of the Kmelnitsky 2-Rivne 4 nuclear reactors in exchange (1994-2000)

"Finally referring to the results of the alternative public hearings organized by NGOs, as well as public opinion poll done by SOCIS – Gallup International in April 2000, they emphasized the lack of people support of the project (only 14% of the respondents supported the project according to the poll)." (page 51).

Poll research to test the social support for nuclear energy was also mentioned in the USA SCR.

According to the Gallup polling organization, nuclear power seemed fully to recover its standing among citizens in the 1990s and 2000s, with those in support of maintaining nuclear energy in a strong majority, even after the Fukushima disaster until 2016. (Newport, 2012, Reffkin, 2016).

(General narrative, p. 20)

B.2.2. Referenda

There are several references to popular referenda in the SCRs considered. Some of these were consultative but others had a compulsory effect.

- *Period 1950-1970*

No mention of this dimension in the SCRs for this period.

- *Period 1970-1990*

An advisory referendum was held in Sweden (1980), partly in response to the TMI accident (Event 2). Despite the result, the Parliament decided to continue nuclear expansion in the short run, but to phase out all nuclear power by the year 2010. A full phase out did not occur.

General narrative

"In the following years nuclear issues were very high on the political agenda. In 1980, partly in response to the TMI accident, an advisory referendum on nuclear power was organized. The referendum campaign engaged hundreds of thousands of activists. The outcome was a defeat for the anti-nuclear side. Parliament decided to continue nuclear expansion in the short run, but to phase out all nuclear power by the year 2010. In the 1980s Sweden became the country with most nuclear power per capita in the world, and it still is. A full phase out did not occur." (page 4).

Event 2: TMI and the referendum on nuclear power

"The nuclear friendly parties in Parliament - the Social Democrats, the Conservatives and the Liberals – were still negative about a referendum and argued that the nuclear issue was too technically complicated for a referendum. To put political pressure behind the demand for a referendum the FMA in the beginning of March 1979 launched a nationwide campaign to collect signatures on a petition for a referendum. On March 28, in the midst of this campaign, the Three Miles Island accident occurred, and all Swedish mass media reported extensively about it. The accident had a major impact on the public opinion, and a week later, Olof Palme, the party leader of the Social Democrats announced that he and his party had changed stance and now supported a referendum. The Conservatives and Liberals soon followed suit. For these parties a referendum was a way to separate the nuclear issue from partisan politics, thus preventing the TMI accident from becoming a big issue in the upcoming elections in September 1979. The decision to organize a referendum was complemented by a decision to postpone the fuel loading of four new reactors until after the referendum (Fjaestad 2008). (…) The details of the referendum were decided after the general elections, which brought a new non-socialist coalition into office, with Fälldin as Prime Minister. After negotiations among the five parties in Parliament, an agreement was reached in mid-December 1979. When demanding a referendum, the FMA had foreseen a straight forward referendum with two alternatives, one for a phase-out and one for a continued expansion of nuclear power. However, the pro-nuclear parties split into two alternatives instead of one, for tactical

reasons. The Social Democrats did not want to support the same alternative as the Conservatives. There were thus going to be three alternatives in the referendum that was to take place on March 23, 1980. Line 1 was supported by the Conservative Party, Line 2 by the Social Democrats and the Liberals and Line 3 by the Center Party and the Communists (and the FMA). Each of the three lines was given 18 MSEK to finance its campaign." (pages 27-28)

In USA in the 70's substantial majorities of the public still favored nuclear power, even as anti-nuclear referenda appeared on ballots in eight States.

In the 1970s substantial majorities of the public still favored nuclear power, even as anti-nuclear referenda appeared on ballots in eight States
(General narrative, p. 19)

- *Period 1990-2015*

A referendum was held in Bulgaria (2013) after several years of public debate among pro and anti-nuclear supporters (Event 5). Although the proposal won in most of the territories, it didn't reach the minimum turnout of 60% to be valid.

Event 5: Referendum for constructing new atomic power plant in Bulgaria- 2013

Regulators started the discussion about this in 2000, when a group of professors and intellectuals established a "**Civil Committee for defence of Kozloduy NPP**". The chair of this committee was Doctor Stefan Vodenicharov. This committee aimed to engage the public with the problem of the safety condition of the first four reactors and to renegotiate their fate. In fact this committee served the interests of the socialist party, which represented the old political regime. These activists tried **to collect over 500.000 signs** in order to have the **referendum** (page 43).

In Sweden a local referendum was also organized by local politicians in the two municipalities' proposed as candidates to host a nuclear waste repository, and in both places a clear majority voted against it (Event 5).

Event 5: A competition for getting a repository

"Existing geological data, e.g. from prospecting for mines, were analysed in detail, and also other conditions were assessed. SKB came to the conclusion that both places could be suitable for a repository. However, local opposition had emerged in both places and it became so strong that the local politicians in both places decided to organize a local

referendum. In both places a clear majority voted against a future repository (Lidskog 1998)." (page 53).

In Ukraine a local referendum was held in the towns near a NPP (1994) (Event 3).

Event 3: Vote on the repeal of the moratorium and relatively weak anti-nuclear protests (1993-1994)

"One of the highlights of the campaign was a local **referendum** on Zaporizhzhia NPP that took place in June 1994 in the largest towns situated in the 30 km zone around the station: Nikopol, Marganets and Kamenka – Dneprovskaia. More than 90% of participants voted against the completion of the unit 6 of the NPP, against the construction of spent fuel storage facility there, and against the exchange of the water between its cooling ponds in the Dnipro River." (page 46).

B.3. Participation

Public participation involves information exchange between members of the public and sponsors. The most significant feature of a participatory engagement is that there is some degree of dialogue in the process. The flow of information is two-way, with the exchange of information opening up the possibility of perception and attitude change in both the sponsors and the public (Rowe & Frewer 2005). Although there are few participatory mechanisms in the strict sense in the SCRs, in this section we outline some initiatives incorporating a participatory dimension (since they allow other actors to influence decision making).

B.3.1. Public hearings, informative meetings, and debates

Some SCRs included references to processes based on informative and deliberative meetings, stakeholders' panels and other types of local public debates.

- *Period 1950-1970*

In Sweden a study group representing both opponents and proponents of atomic weapons was created, generating recommendations for government policy (Event 1).

Event 1: The atomic weapons controversy

> "A special study group was setup to formulate a compromise. This compromise partly led to the dissolution of AMSA, which was replaced by a new political organization - inspired by the British CND - organizing protest marches and other public events." (page 39).

In the UK, after the Windscale fire (1957) concerns raised locally were addressed by public meetings organised by the promoters' staff, as well as in meetings with local farmers concerned about potential risks to their livestock (Event 3). These meetings provided feedback on the perceptions and experiences of locally affected people.

> *Event 3: Windscale Fire 1957*
>
> "Public information about the fire was heavily restricted and controlled by the government. There was intense newspaper coverage of the events; however, this was dependent on the release of information from government." (page 37).
>
> "Concerns raised locally were addressed by public meetings organised by Windscale staff, and meetings with local farmers concerned about the effects of the fallout on their livestock.(Arnold, 1992; Stretch, 2002) Although a milk ban was in place for a month farmers were protected from financial damage by compensation by the government (distributed through the Milk Marketing Board)." **(page 36).**

- *Period 1970-1990*

In Sweden, information meetings with experts of pro and anti-nuclear issues were organized, sometimes leading to the conclusion of giving up a siting process (Event 3).

> *Event 3: Local protests against a repository*
>
> "The local politicians in both places did their very best to convince SKB about the advantages of their place. SKB arranged a number of meetings and consultations with local people in both places to inform them about how the repository would be built." (page 53).
>
> "After the first attempt to set up a proof drilling site had failed, the organization that was responsible for the proof drillings, PRAV, organized several information meetings when their experts explained the principles of the intended repository. But Save Kynnefjäll enrolled counter experts that questioned these experts and the local population remained hostile to drillings. As a result PRAV decided to give up its attempts to establish a drilling site there." (page 45).

- *Period 1990-2015*

In Spain, since 2000 local information committees have been created in all the NPPS, which included representatives of the main stakeholders. These are official participatory bodies. In the meanwhile, similar bodies (local information commissions) were created by the municipalities. Informative committees and Joint Commissions including mayors, social representatives and regulators were constituted in potential nuclear siting villages (Showcase, Events 2 and 5). Some environmental movements did not agree with the way in which such committees functioned (they considered them biased).

General narrative

"Since 2000, Local Information Committees have been opened in all operative NPPs, a kind of information bodies composed of a representative of the Ministry of Industry, the owner of the facility, the Nuclear Safety Council (regulator), the Government Delegations and the regional public authorities where the installation is located, the General Directorate of Civil Protection and the Municipalities included in Zone 1 defined in the corresponding emergency plans. Its functions are to inform the different entities represented about the development of some of the activities (only those regulated in the corresponding authorizations) and to jointly deal with those other issues of interest to said entities. In this sense, it is an organ that allows a certain participation of several actors (basically members of the nuclear industry and of the public authorities in its different levels, whereas the social movements and other citizen sectors are not represented). In 2005 the AMAC created other similar bodies (Local Information Commissions) but also including cultural, business and union associations in the area. There were plans to coordinate both type of bodies (Local Information Committees and Local Information Commissions)." (page 63).

Event 5: NWR

"The site for the nuclear waste repository is the first example of a selection process for a site which aspired to be inclusive and consensual. The range of the parties involved - public and private, local, regional, national and supranational - was very wide indeed. The Government promoted the creation of **Local Committees of Information** in the candidate villages, as suggested by COWAM (Community Waste Management)." (page 58).

"Environmental associations, such as Greenpeace or Ecologistas en Acción, become active actors in terms of engaging with process, as follows: started a litigation questioning the formal procedure of the contract; criticised the performance of the Nuclear Safety Council (CSN); and denounced relevant risks involved in the transport of waste as it passes through 216 municipalities." (page 57)

In Sweden, Regulators strived to engage the local receptors in their studies. In the first failed strategy, the two selected municipalities showed a local opposition, but in the two municipalities which already had local power plants, the strategy was successful and many locals were actively involved in deliberations. (Event 5, p. 52-54).

Event 5: A competition for getting a repository

"After a long evalution process SKB reached the decision in 2009 that Östhammar would be the best place for the future repository for geological reasons. They simultaneously decided that the future plant for constructing copper canisters for the spent fuel would be located next to the existing interim storage facility in Oskarshamn." (page 52)

"The local politicians in both places did their very best to convince SKB about the advantages of their place. SKB arranged a number of meetings and consultations with local people in both places to inform them about how the repository would be build. After a long evalution process SKB reached the decision in 2009 that Östhammar would be the best place for the future repository for geological reasons." (page 53).

"When SKB turned to two municipalities with nuclear power plants both politicians and a large part of the population were favourable to a repository and even a sort of contest emerged between them." (page 54).

In the UK an extensive consultation was organised by the regulators in order to address concerns about nuclear energy and provide more information, based on citizen's panels and focus groups, which indicated public acceptance of companies investing in nuclear power (Event 7). The 'public consultation' process organised by the regulators fed back into policy decisions being made by BERR (Department for Business, Enterprise and Regulatory Reform) and did have an impact on the 2008 Energy White Paper on Nuclear Power. Regulators concluded that nuclear power might result an unattractive option due to economics. This made governments to take a decision based in a public consultation. The promoters/regulators of nuclear power looked for the energy policies and due to their concerns on climate change the put again in the political agenda the issue of nuclear power. The controversial debate on nuclear power made difficult to get success on the effort for public engagement. Moreover, receptors led by the environmental organisations did not attend them believing the decision had already been taken. They were lacking trust on the consultation procedures.

Event 7: Government repositioning on new build NPPs 2006

"In 2003 the Department of Trade and Industry's White Paper concluded that the economics of nuclear made it 'an unattractive option for new, carbon-free generating capacity' and pledged that 'Before any decision to proceed with the building of new nuclear power stations, there would need to be the fullest public consultation and the publication of a white paper setting out the Government's proposals." (page 50).

"An extensive **consultation** was organised by the regulators in order to address concerns on the nuclear energy and

provide more information. The following 2008 Energy White Paper on Nuclear Power, published details of its extensive consultations in detail. Multiple agencies were contracted to host and analyse **citizen's panels and focus groups** which would indicate public acceptance of allowing companies to invest in nuclear power. Couched in terms of the governments' response to climate change, the public were asked their opinions on the safety and reliability of nuclear power compared with renewable sources, and the extent to which the UK should seek to replace (or increase) its nuclear generating capacity. Replies were mixed, highlighting moral concerns about nuclear power, but also indicating a reluctant acceptance that nuclear power was a necessary part of the energy mix in a low-carbon economy." (page 49)

In Ukraine a series of public consultation and public participation procedures were implemented in Ukraine. Several public hearings were organized by regulators and promoters in the villages situated in the vicinity of the proposed NPPs. Ukrainian environmental and anti-nuclear NGOs actively participated in these meetings, but some of these movements also organized alternative hearings. (Event 4, p. 50-51).

Event 4: Controversial negotiations on the closure of the Chernobyl NPP and public hearings on the completion of the Kmelnitsky 2-Rivne 4 nuclear reactors in exchange (1994-2000)

"As for the completion of the K2-R4 reactors, according to the EBRD rules regulating investment projects, a series of public consultation and public participation procedures were implemented. EBRD representatives organized a number of round-tables and consultations with different stakeholders: government officials, representatives of different nuclear organizations as well as NGOs. Several public hearings were organized as part of the environmental impact assessment of K2-R4 in cities and villages situated in the vicinity of the plants. Ukrainian environmental and anti-nuclear NGOs actively participated in these hearings. They criticized the hearings as events organized as a "mere formality" as opposed to attempts really to take into account the opinion of the local population (Pasyuk 2016). Several local NGOs organized alternative hearings that, according to activists, showed very critical attitudes of local population towards the construction project (Fedorynchyk 2000)." (pages 50-51)

B.4. Public-initiated engagement'

What we called 'public-initiated engagement' refers to the communicative actions directed from the public to regulators, public authorities or nuclear companies. Usually these initiatives

mobilized large numbers of people, mainly activists, and they could be expressed as public demonstrations on the street and other social mobilizations (as collecting signatures, etc.), sometimes including violence and/or illegal acts.

B.4.1. Signature collection

The SCRs revealed a number of occasions in which signatures were used to try to communicate public disquiet about a nuclear development. Collecting signatures appealing against the siting or the construction of nuclear facilities has become one of the usual instruments of the affected people and social movements (receptors). Sometimes the signatures are collected to ask for a referendum on nuclear issues.

- *Period 1950-1970*

In Sweden the social movements collected signatures for a plea for a referendum on nuclear weapons (Event 1); and also for a referendum on nuclear power after the TMI incident (Event 2).

> *Event 1: The atomic weapons controversy*
>
> "The group made a **plea for a referendum** on nuclear weapons, and started to gather **signatures** for their plea, but were not able to muster the necessary number of signatures. When this campaign failed, the group more or less dissolved." (page 11).

- *Period 1970-1990*

In Germany people against the project of building a NPP collected and submitted 100.000 signatures (Event 2).

> *Event 2: Wyhl (planned but never built nuclear reactor)*
>
> "A year later it became publicly known that a new site in Wyhl had been found, which was only a few kilometers away from the original site and caused direct opposition again, this time well organized. In 1973 and 1974 some 100,000 signatures and appeals against the construction of the nuclear power plant were submitted, including to the federal minister of the interior, who at that time was Werner Maihofer (FDP, liberals)." (page 25).

In Spain, social movements against a NPP collected signatures among university experts, and several times they collected more of half a million of signatures (Event 2).

> *Event 3: Basque antinuclear movement*
>
> "They (Receptors) used a variety of protest actions as **signature collection** (over 150,000), and informative lectures." (page 47).
>
> *Event 5: NWR*
>
> "Social movements pro NWR performed **signature** collection and demonstrations."(page 58).

In Sweden the social movements collected signatures also for a referendum on nuclear power after the TMI incident (Event 2).

> *Event 2: TMI and the referendum on nuclear power*
>
> "The FMA had been established in March 1978 as an effort to create a national umbrella organization for the rather heterogeneous anti-nuclear movement. It encompassed a dozen organizations, some of which were non-political environmental or peace organizations, while others were political organizations." (page 27).
>
> "To put political pressure behind the demand for a referendum the FMA in the beginning of March 1979 launched a nationwide campaign to collect signatures on a petition for a referendum." (page 27)

- *Period 1990-2015*

In Ukraine social movements (Greenpeace) collected signatures against the repeal of a moratorium and the construction of new reactors (Event 3).

> *Event 3: Vote on the repeal of the moratorium and relatively weak anti-nuclear protests (1993-1994)*
>
> "Greenpeace, which established its local branch in Ukraine on the eve of the country's independence, launched an anti-nuclear campaign, with memorable activities such as the **bus tour** "No new reactors!" that aimed at informing people about the problems related to the pursuit of nuclear power in Ukraine and **collected signatures** against the repeal of the moratorium. They promote the collection of over **15,000 signatures against the construction of new reactors** that were later transmitted to the Rada of Ukraine." *(page 45-46)*

B.4.2. Demonstrations and social mobilizations on the street

The main way in which the population has shown their rejection of NPPs and tried to influence the decision making on nuclear energy is through public demonstrations on the streets. All of the selected countries' SCRs include references to this type of public action, often described as occurring with some degree of violence. Large protests and confrontations with police were continuously organised to show opposition to nuclear facilities and developments.

- *Period 1950-1970*

In the USA, in the 60's, the public opposition of the Committee Against Nuclear Power Plants eventually influenced the withdrawing of the application for a construction permit of a NPP in New York (Ravenswood project) (Showcase, p. 22). During these same years public protests were crucial to Preserve Bodega Bay in California (protesters had grown to about 800 members opposing a NPP project).

> One of the first controversies concerned the application of the Consolidated Edison (ConEd), Inc. – one of the largest investor-owned electrical companies in the US that provides electricity to New York City, to build a 1,000 MW NPP in Ravenswood, Queens, only two miles from the UN. (…) The group "CANPOP" -- Committee Against Nuclear Power Plants -- formed to protest. ConEd's Ravenswood application made the AEC consider more systematically whether to permit the construction of nuclear power plants in large cities. Eventually ConEd withdrew its application for a construction permit.(Mazuzan, 1986)
>
> (Showcase, p. 22)
>
> Public involvement was crucial here. By December 1963 the Northern California Association to Preserve Bodega Head and Harbor had grown to about 800 members who opposed the station. Many people believe its success had much to do with the efforts of its executive secretary, David Pesonen, a man who wrote extensively, including an editorial critical of Price-Anderson in New Republic in 1965. Pesonen worked at the Sierra Club and represented it at hearings on Bodega Bay at the California Public Utilities Commission. Personen noted that the reactor would be only a few hundred feet of the San Andreas fault, and even PG&E experts admitted that a major earthquake like the 1906 San Francisco earthquake was possible within a century. Yet those experts believed that they could build an NPP to withstand an earthquake of major proportions, and insisted on the "absence of active faults."(Walker, 1990) As protests grew, PG&E played hardball accusing the association of being a communist front organization.
>
> (Showcase, p. 23)

- *Period 1970-1990*

In Bulgaria, after Chernobyl accident, the lack of any information provided to the public led to protests against nuclear establishments (Event 3, p. 38). The creation of opposition voices was first leading to information request on the consequences that were not duly communicated – the issue of on time communication. A spontaneous reaction to environmental problems conformed Ekoglasnost as a social movement very influential in the country debates.

Event 3: Reaction of the Green movement to the Chernobyl accident

"Activists in Ekoglasnot demanded mainly information about the environmental pollution caused by big technological projects and the Chernobyl accident. It was the first free public reaction related to nuclear power program. In 1989 started as **spontaneous reaction** to environmental problems. Regarding public participation, as Bulgarian green activists protested against the inadequate measures of the Communist party after Chernobyl accident and the lack of any information provided to the public. This led to **protests** against nuclear establishments in the state. Other mentioned activities that receptors did to protest about the criminal behaviour of the communist ruling elite finally shed light on the truth, being one of the themes was named Future without atom. From this moment onward, environmental problems became matter of **public discussions and forums** in otherwise closed totalitarian society." (page 38).

In the F.R. Germany the opposition against nuclear power has been specially strong and violent, and numerous protests and communication activities coming from opponents were repeatedly organised over the country (General narrative, p. 13; Showcase, p. 19). The site for an interim storage unit for dry cask storage was built between 1981 and 1983 in the face of massive protests and collisions with police (Event 4, p. 30-31), and ended with many injuries among protesters. Besides, in Germany (events 2, p.25; and 3, p. 27) site occupation appears as a kind of mechanism different of the demonstrations, or rather, a different operationalisation of this protest mechanism. (i.e. in 1974, at Wyhl, West Germany, 28,000 people occupied the site of a proposed nuclear station to stop its construction in a nature preserve, and people remained on site until the project was abandoned).

General narrative

"Historiography has given various reasons why the opposition against nuclear power was generally **strong** in Germany and also **violent** at times. Historians found answers in Germany's national socialist past, which might have resulted in a strong skepticism towards the authorities as well as a lack of religious influences in the movement, as can be found in the United States." (page 13).

Showcase: Scientific-technical institute for reactor construction (WTBR) and research centre for limnology

"Soon criticism arose about the building of the fast breeder, based on doubts about the safety of nuclear energy, and in 1974 around a thousand people, predominantly from the Netherlands, took to the streets. A mass rally three years later was attended by 40,000 people (some authors speak of 50,000 [Tompkins, Grassroot(s) 2016, 129] or even 60,000 people, [Mende 2011, 332]) from France, the Netherlands and West Berlin. The police presence is regarded as the biggest in the history of the Federal Republic of Germany. The police were extremely violent and many demonstrators felt they were treated like terrorists." (page 19).

Event 2: Whyl (planned but never built nuclear reactor)

"This did not change the political decision at first and on 17 February 1975 the construction of the first reactor was started even though the final license for the building of the nuclear power plant had not yet been granted. This provoked opposition again, mostly from local people, many of them wine farmers, who spontaneously occupied the site and were supported in their resistance by activists from the nearby town of Fribourg. Crucial to this resistance was the successful fight against the erection of a lead chemical plant in Marckolsheim in neighboring French Alsace on the other side of the river Rhine." (page 25).

Event 3: Wackersdorf (planned but never built reprocessing plant)

"Even though other possible sites were debated, Wackersdorf was chosen because a "high potential of protest [...] (was) not to be expected" (Schardinger 2012, 18). In 1985 the DWK finally decided on Wackersdorf as appropriate location for the construction site and announced the development plan. After the clearing of the woodland had started, a major demonstration with 30,000 people took place in Wackersdorf. Demonstrators occupied the building site, erected a hut village, and called it "Freies Wackerland" (free Wackerland) (Knoll 2006). Citizens' initiatives, such as the Mothers Against Nuclear Power, raised objections to the reprocessing plant at a hearing in Neunburg. Here, they claimed for themselves and their families, especially their children, the fundamental right to life, health, physical integrity, and free development of their personality, which they did not see as being guaranteed if the reprocessing plant was build (Wurzbacher 1988, 1)." (page 27)

Event 4: Gorleben repository site

"The site for an interim storage unit for dry cask storage was built between 1981 and 1983 in the face of massive protests and collisions with police. Protesters suffered from fractured ribs, insured kidneys, fractured heads, and blinded eyes that were caused by water guns (Geisler 2010). Opponents of the transports were systematically spied on by police and the Federal Agency for State Protection and Counter Terrorism (Verfassungsschutz 2001). Because of litigations and massive protests, the plant only started operating in 1995 with the first so-called Castor (cask for storage and transport of radioactive material) transport." (page 30-31).

In Spain, anti-nuclear activist began to be more visible after the end of Franco's dictatorship (mid-seventies) with informative sessions, concentrations and parades (General narrative, p. 17). During this period, in Spain, big demonstrations in the street against nuclear projects were going

in parallel with terrorist attacks causing human victims and material harms (Event 2, p. 43; Event 3, p. 47).

General narrative

"But even before Franco's dead, there were unstructured informal social groups, with strong leadership from small group charismatic people, which pushed for the formal complaints by local authorities in most of almost 20 locations where there were talks for a nuclear project. Some civil strategies, illegal within the dictatorship -meetings, pamphlets, demonstrations, parades, voluntary confinement, etc. - would spring after the dead of the dictator in 1975. Opposition to nuclear power also came from people within the Franco's regime (mayors, provincial governments, religious associations, agricultural unions, etc.)." (page 17).

Showcase: Valdecaballeros NPP (built but never operative reactor)

"The local government and the utilities tried to continue with the building of the NPP. According to the Mayor of the town: "Workers **mobilized with strikes**, people were very worried, some assemblies in the town hall, meeting with the government of Extremadura, we **occupied** the church… we did a lot of things but they weren't useful at all" [they were protesting against the nuclear moratorium that stopped the NPP]." (page28-29).

Event 2: Ascó

"In March 1978, the opponents organised the first antinuclear demonstration in Barcelona, in which more than 50,000 people took part, demanding a nuclear moratorium and a stop to Spain's National Energy Programme. In June 1978, on the occasion of the International Day against Nuclear Energy, more than 100,000 people demonstrated in Barcelona against nuclearizing the country." (page 42).

With the support of an extreme left wing break-away circles a series of violent actions (about 30 actions from 1980 until 1992) were perpetrated by the terrorists' movement "Terra Lliure" (Free Land) against companies that owned the plant (page 41)

"This resulted in campaigns which were directed towards international institutions and autonomous communities with the GCTPFNN as unifying group. Some of the mottos of the campaigns include: "Let's not Nuclearize the Climate" ("No nuclearitzem el clima", 2000), "Sustainable Nuclear? By No Means, 2001 ("Nuclear sostenible? de cap manera", 2001), European Petition against the use of radioactive weapons) "Petició Europea contra la utilització d'armes radioactives. *(page 43)*

Event 3: Basque antinuclear movement

"Demonstrations of more than 50 thousand people took place these years (late 70s and early 80s) (some of the largest demonstrations in the Basque Country after the Civil War)." (page 47).

"The whole period 1977-1983 settled with 13 deaths. To those ETA added other kidnappings, more than 300 bombs on the electricity network, Iberduero offices and, other companies involved in the construction of the plant. The clandestine sabotage of the works of the plant produced serious doubt on safety of ever operating the plant." (page 47).

In the case of Sweden, several references to local opposition and large public demonstrations are identified. For instance, the referendum campaign became a mass movement of grassroots activists all over Sweden (Event 2, p. 17). Protests against a repository by local activists became a process of local mass campaigns but they also erected blockades and stolen materials (Event 3, p. 47-48). And when Chernobyl accident took place hundred of demonstrations were arranged in many places all over Sweden, with thousand people demanding the phasing out of nuclear projects (Event 4, p. 50).

Event 2: TMI and the referendum on nuclear power

"The referendum campaign dominated political life and the mass media for several months. The Line 3 campaign became a mass movement of grassroots activists all over Sweden. They organized demonstrations, public meetings, distributed campaign newspapers, and knocked doors to talk with ordinary people." (page 17)

Event 3: Local protests against a repository

"These local organizations primarily campaigned locally to get support for their opposition, but at a few times also used **illegal methods**, like erecting blockades and stealing materials from proof borings to let their counter experts analyze them." (page 48)

"These groups not only held meetings and created **strong local oppositions**; they also formed a network called the Waste Chain, which engaged critical geologists, chemists and engineers in a critique of the KBS method at large." (page 47).

"SKB was aware of the importance of the reactions of local population and their first strong reaction against the repository location, they changed their exploration site strategy towards a more **public engagemen**t process. SKB reached the conclusion that it would be impossible to establish a repository at a site where the **local population was strongly against** it. (page 47)

Event 4: Chernobyl and its effects in Sweden

"When the Chernobyl disaster occurred, the anti-nuclear movement was thus severely weakened after several years of decay. The disaster led to a revival. The former members put on their "nuclear power – no thanks" badges again, and in mid May 1986, demonstrations were arranged in many places all over Sweden, and ten thousand people gathered in central Stockholm demanding an immediate start of the phasing out of nuclear power." (page 50).

In the UK, the environmental movement Greenpeace staged non-violent protests, blocking at-sea-disposal by the UKAEA using their boat Rainbow Warrior. (Event 5, p. 43)

Event 5: Royal Commission on Environmental Pollution 1976

"Greenpeace staged **non-violent protests**, blocking at-sea-disposal by the UKAEA using their boat ***Rainbow Warrior***. Greenpeace established links with the National Union of Seamen, whose members then refused to work on UKAEA boats carrying nuclear waste. This direct action changed UK policy from one of at-sea-disposal to one of dry-storage." (page 43).

In Ukraine, during the 3-4 years after the Chernobyl accident popular protests on the street increased, leading to a moratorium on the construction of new NPPs (Showcase, p. 38). Some years later, local public protests were organized also in order to protest against a NPP. Among receptors, the almost three-year-long cover-up of the impact and scale of the Chernobyl accident radioactive fall-out ended with an explosion of popular protests in 1989 (Event 2, p. 38).

Showcase: Dealing with the Chernobyl disaster aftermath

"Such environmental groups as Zelenyi Svit, Mama-86, grew rapidly in 1988-1990, and sought to establish an independent Ukraine as a nuclear free zone. Anti-nuclear mobilization on local level and in Kyiv contributed to a moratorium on the construction and commissioning of new nuclear power units by the Ukrainian Parliament in August 1990." (page 38).

Event 2: Post-Chernobyl anti-nuclear protests and vote on the moratorium on the construction of the new nuclear reactors (1989-1991)

"The extent of the disaster was finally revealed to the general public in 1989, an important **mobilization** took place to denounce the mismanagement of Chernobyl disaster by Soviet authorities and to claim better protection and compensation for affected population (page 38).

In the USA, one of the first massive public protests against nuclear power gelled around the Diablo Canyon station. Eventually roughly 60 anti-nuclear groups and 30,000 people came together in protest. (Event 2, p. 33-34). Besides, the Clamshell Alliance, an umbrella organization of 15 anti-nuclear groups, was formed at a July 1976 with the goal of the halting the Seabrook NPP construction and to force cancelation of the project by any means necessary within the context of "non-violent direct action (Event 4, p. 44). Years later, in 1985, hundreds of demonstrators descended on the plant when PSNH began the first power tests in June 1985, with 627 arrested for trespassing.

Anti-nuclear groups worked together. Eventually roughly 60 anti-nuclear groups and 30,000 people came together in

protest.

(Event 2, p. 33)

1981 Abalone Coalition Occupation of Diablo Canyon, https://www.youtube.com/watch?v=MPBtwfYcy-M (Irving, 1981)

(Event 2, p. 33)

One of the first public protests against nuclear power gelled around the Diablo Canyon station. The Abalone Alliance (1977-1985) took its name from the multitudinous red abalone massacred in Diablo Canyon in 1974 when the utility carried out a hot flush of the reactor unit's plumbing. The Alliance, "a loose coalition of 60 anti-nuke organizations, staged blockades and occupations at the reactor site. Nearly two thousand people were arrested during a two-week blockade in 1981, making this the largest number arrested at an anti-nuclear protest in the United States. Perhaps as many as 30,000 protestors descended on the site.(Rogers, 1981)

(Event 2, p. 34)

In 1972 the company proposed to build two reactors on the Hampton-Seabrook estuary, of salt marshes and critical habitat for birds and other fauna, along the Atlantic Ocean in Seabrook, NH, the first to come online by 1979, the second in 1981, with a total cost of less than $1 billion. The plans generated extensive public opposition, protest, and occupation of the construction site by the Clamshell Alliance. Protests continued into the 1990s.

(Event 4, p. 43)

In 1978 the Clamshell Alliance split after its Coordinating Committee (CC) agreed to call off a large civil disobedience planned at the power plant site in June, instead of obtaining input and consensus from regional Clam groups. The government of New Hampshire had negotiated the opportunity for the Alliance to hold pro-solar power and music festival at the Seabrook site to avoid bad publicity and the cost of law enforcement. Twenty thousand people attended. In response a more feeling that a massive arrest on the site would overwhelm the state, undermine support and finance for the Seabrook nuclear project, and also result in the costs of hiring police from neighboring states, incarcerating thousands of Clams and paying court expenses offered to let Clamshell hold a solar power fair and concert on the site. This proposal was eventually accepted by Clamshell and a highly successful rally of 20,000 people was held on the site with thousands of Clams also camped out on the Seabrook site. But the political consequences within Clamshell led to a split in the Alliance and the eventual formation of the Coalition for Direct Action that called for continued occupation. (Coalition for Direct Action, 1979)

(Event 4, p. 44)

In 1974, at Wyhl, West Germany, 28,000 people occupied the site of a proposed nuclear station to stop its construction in a nature preserve. People remained on site until the project was abandoned. Seeking similar results, The Clamshell Alliance, an umbrella organization of 15 anti-nuclear groups, was formed at a July 1976 meeting of 50 people, almost all of whom were NH residents. The goal of the Alliance was to halt Seabrook construction and to force cancelation of the project by any means necessary within the context of "non-violent, direct action."(Coalition for Direct Action, 1979)

As soon as the NRC issued a construction license in summer 1976, 200 New England residents rallied at the edge of

> the future power plant site, on the seacoast saltmarsh as the Clamshell Alliance, 18 of whom were arrested for "criminal trespass" and sentenced to time in jail. A week later, 188 other New England citizens returned to the Seabrook site; they too were arrested. As one of the founders wrote, "By the early spring of April 1977, two thousand 'Clams,' as they came to be known, had returned to the site to non-violently reclaim the land and declare the ocean front 'nuclear free." Over the years dozens of clams were arrested for nonviolent civil disobedience at Seabrook in the effort to stop nuclear power, including two state legislators, one from Massachusetts and one from New Hampshire.(US NRC, 1979; Gunter, 1990)
>
> Hundreds of demonstrators descended on the plant when PSNH began the first power tests in June 1985, with 627 arrested for trespassing. The protesters included children and handicapped people.
>
> (Event 4, p. 46)

- *Period 1990-2015*

According to the Spanish SCR, there where several examples about ecologist and social movements protesting in localities showing interest to host the facilities. (Event 5, p. 57)

> *Event 5: NWR*
>
> "People against the ATC made popular demonstrations, and information events.." (page 57)

In Ukraine, environmental movements organized anti-nuclear pickets and public roundtables discusing the moratorium (in the 90's), and they also hung a big banner on the cooling towers of a NPP to protest against the future development of nuclear power in the country. (Event 3, p. 46)

> *Event 3: Vote on the repeal of the moratorium and relatively weak anti-nuclear protests (1993-1994)*
>
> "Together with the members of such other NGOs as Zelenyi Svit and the Green Party of Ukraine they participated in numerous anti-nuclear pickets in Kyiv (in front of the Rada), wrote letters to the Rada, met with parliamentary representatives, and organized public roundtables discussing the moratorium (Pasyuk 2016; Tsvetkova 2016)." (page 46).
>
> "In August 1994 Greenpeace Ukraine together with Zelenyi Svit activists in Nikopol hung a big banner "No more Chernobyls" on the cooling towers of the station to protest against the future development of nuclear power, and handed a protest note to the nuclear power plant management (Pasyuk 2016; Tsvetkova 20016; see also the video: Greenpeace Ukraine 1994)." (page 46).

B.4.3. Manifestos, books and other public communicative tactics

Among the Receptors' 'public-initiated engagement' we can also identify classic ways of disseminating messages and information, such as press releases, media interventions, edition of books, manifestos, etc. Social media deserves also a specific attention because it implies a fluid, reactive, constantly updating process, unlike traditional media communications which are one-shot and indelible. Besides, sometimes mediatic celebrities or social significative persons were used by the Receptors to visibilize their demands. Hereby we show the initiatives of these kind found in the SCRs.

- *Period 1950-1970*

In Sweden the influence of some scientists writing articles in newspapers and contacting politicians seemed to have great influence in the decision making process (mainly from a perspective of maintaining peace) (General narrative, p. 15).

General narrative

"The single person that most strongly contributed to this shift was a scientist, **Hannes Alfvén**. He became increasingly critical of nuclear power and started writing **articles in newspapers** and **contacting politicians**. He even wanted to give a **speech** at the first UN conference on the Environment Alfvén soon became a very influential nuclear critique as his knowledge and insight could not easily be questioned. Also a number of other Swedish scientists and nuclear experts were influenced by the critique formulated by Alfvén and colleagues abroad, but as many of them worked (directly or indirectly) for the Swedish nuclear industry they were hesitant to formulate their critique publicly." (page 14).

"However, the growing criticism of nuclear power among scientists, politicians and environmental activists led to an intensive public debate. Many critical articles were published in large daily newspapers, the first critical books were published (Kågeson 1973) and environmental groups distributed many pamphlets and posters." (page 15).

Event 1: The atomic weapons controversy

"It was very informal without any membership fees, no board and it was limited to the 21 people that joined from the beginning. These included some well-known authors, journalists and academics and the Arch Bishop. They had their sympathies with different political parties, but none of them was communist. One reason for not admitting more members was that AMSA did not want to be suspected to be a pro-communist organization. Moscow spurred communist parties in Western Europe to create peace organizations opposing nuclear weapons, and the Swedish Peace Committee was one of these." (page 36).

- *Period 1970-1990*

In the Spanish SCR there are references to articles and press interventions, books, support of celebrities, intellectuals, lawyers, etc. (General narrative, Events 2 and 3).

> *General narrative*
>
> The public voice could also be heard, especially in regions where building nuclear power plants had already commenced, and **local press coverage** brought lobbying by stakeholder groups into the public eye (page 17).
>
> The Environmental movements joined forces to write and distribute a **book** of over 600 pages explaining their position (page 31).
>
> *Event 2: Ascó Nuclear Power Plant*
>
> "The villagers did not react to this announcement until some of them came across an article by Mario Gaviria "*La amenaza de la energía nuclear*" ("The menace of nuclear energy" Triunfo, 2nd February 1974) on the potential danger of these installations. Some started worrying and founded a group that took a critical stance on the project during the ensuing pronuclear discussions. (…) Later the Comitè Antinuclear d'Ascó and the CARE drew up a new document in which they expounded their opposition to use water from the Ebro river to cool the NPP reactors." (page 40).
>
> *Event 3: Basque antinuclear movement:*
>
> "Antinuclear activism hires a prestigious **lawyer** and began **traveling** through Europe seeking information, pursuing **support** from other municipalities in the province, from cultural organizations and, and from **celebrities**. (World's renowned sculptor Eduardo Chillida designed the antinuclear logo)." *(page 46)*

- *Period 1990-2015*

The Spanish SCR includes also some cases of Internet social networks (twitter) and website resources used by actors pro and against a nuclear waste repository.

> *Event 5: NWR*
> "Actors pro and against the NWR sitting made a wide use of **Twitter** and **website** resources." (page 57).

In the USA report hundreds of activists sent letters asking state officials to oppose restarting Davis-Besse NPP (in 2004). Years later, in 2012, used a skit to protest in front of the NPP.

> In 2004 over 400 activists who sent letters last week asking state officials to oppose restarting Davis-Besse. In June 2011 over 250 anti-nuclear protesters who braved the rain and wind to protest the continued operation of the Davis-Besse nuclear power plant. In January 2012 About 20 people participated in a skit in front Davis-Besse Nuclear

Power Station before they attended a public meeting about shield building cracks at the plant. "We have nuclear-grade duct tape, nuclear-grade Gorilla Glue and nuclear-grade spackling," said Kevin Kamps, dressed as C. Montgomery Burns, the owner of the Springfield Nuclear Power Plant in "The Simpsons."

(Event 5, p. 49)

B.5. Other ways of influence on nuclear decision making: Legal, administrative and political routes

The SCRs include some references to processes of legal actions and political pressures trying to influence the decision making on nuclear issues. Although these mechanisms do not imply a real participation because they do not allow a real debate among the actors, they are examples of other existing ways to influence decisions different to the engagement processes,

In fact, in some cases the legal actions of affected municipalities (receptors) were able to influence decision making, even paralyzing certain projects.

- *Period 1950-1970*

In the USA, the relatively litigious American legal and administrative system permits interveners to exert influence on the technology assessment process, and many people have sought to participate in the regulatory process directly through petitions and lawsuits. (General narrative, p. 18).

> The relatively litigious American legal and administrative system permits interveners to exert influence on the technology assessment process. Building on the anti-war and environmental movements of the 1960s, and especially since the 1970s, the establishment of the Environmental Protection Agency, the Occupational Safety and Health Administration, and other regulatory and safety bodies, many American citizens have sought to participate in the regulatory process directly through petitions and lawsuits.
>
> (General narrative, p.18)
>
> Detroit Edison formed the Power Reactor Development Company (PRDC) to move Fermi ahead. In the late 1950s the United Auto Workers brought suit to halt construction because of safety concerns, and lost eventually in the US Supreme Court, 7-2. Other public concern was limited by AEC secrecy. (US SC, 1961)
>
> (Event 1, p. 29)
>
> Although the UAW lost the court case concerning Fermi, their legal activities helped establish strategies and procedures for future intervention. The Fermi accident did not change AEC regulatory procedures or increase openness. This would be some time in coming.
>
> (Event 1, p. 30)

- *Period 1970-1990*

In the F.R. Germany, social movements opposing nuclear installations lodged in court against siting (Event 2, p. 26).

General narrative

"Since the opponents of the construction lodged a constitutional complaint before the Constitutional Court, the German parliament's commission of inquiry ordered that construction be interrupted for four years in light of the safety concerns." (page 21).

Event 2: Whyl (planned but never built nuclear reactor)

"In March 1977 the administrative court withdrew the construction license for .the plant. But two years later the administrative court of Baden-Württemberg opened up a second case. In 1982 the court of justice decided again that the construction of the nuclear power plant was legal and caused a rally of 30,000 opponents." (page 26).

In Spain, administrative and legal litigation by local authorities against chosen nuclear locations became the initial strategy in most cases in Spain (in early times) (general narrative). In other cases the main way to influence decisions was to co-opt the local governments (in Event 2 both promoters and receptors tried to do it).

General narrative

"Under the Francoism civil society could not manifest itself openly with police controls and press censorship in place. Even in the later, all the civil rights common to other Western countries did not exist. However, administrative channels offered the opportunity to show dissatisfaction." (page 15)

Democracy led to public debate and, from 1977 onwards, the government Energy Plan was reviewed, discussed, and approved in a **multi-party parliamentary** setting (page 16). Eventually municipalities in the influence area of NPP got organized. The origin of the Association of Municipalities in Areas of Nuclear Power Plants (AMAC) dates back to 1988. AMAC was legalized as such from a meeting held in Cofrentes (Valencia) in February 1990. From that moment, it has been working in **monitoring** the operation of NPP, in the implementation of the Nuclear Emergency Plans, the democratic management of radioactive waste and the creation of effective economic development policies for areas belonging to the Association (page 18).

Event 2: Ascó

"This strategy finally failed in the second democratic municipal elections (1983) when the FECSA compelled all its employees to take up residence in Ascó so that these could vote in local elections and in this way contribute to decisions which favoured the nuclear plant." (page 41).

"Between 1977 and 1979 Catalonia recovered its autonomous government, the first democratic municipal polls elected new mayors and mixed commissions had to be formed to address territorial questions. One of the most prominent

campaigners became the first democratically elected mayor of the village of Ascó on an anti NPP list." (page 40)

In the UK, the public inquiries constitute an interesting participative mechanism as it ensures that several viewpoints in conflict are able to be heard (Event 6, p. 47).

Event 6: Sizewell B public inquiry 1982-5

"The legalistic nature of the setting prevents a discussion about the general concepts of the installation from being discussed. For example, at the Sizewell inquiry, organisations such as Greenpeace were unable to discuss the benefits/disadvantages of nuclear power stations in general and instead had to demonstrate why the plans for that nuclear station in that particular location did not meet legislative standards." (page 47).

- *Period 1990-2015*

In Spain, in the case of the siting of a nuclear waste repository, a participative process was promoted through the voluntary candidatures of municipalities (which had before to approve the candidature by voting in the city hall) (Event 5, p. 57). Besides, it is worth noting that an association (AMAC) made of municipalities hosting nuclear infrastructures was monitoring the management of nuclear issues, acting as a kind of check and counter-balance to the decisions made by promoters and regulators.

Event 5: NWR

"The proposal of Ascó was approved by an absolute **majority in the City Hall Council**. The same happened in the other candidate villages aiming to take in the NWR." (page 57).

In Sweden, several municipalities competed in hosting a nuclear waste repository in Sweden. The Public authorities sent a letter to all municipalities asking for their interest in the process, emphasizing that the process would be based in voluntariness (Event 5, p. 54).

Event 5: A competition for getting a repository

"In 1992 SKB sent a letter to all municipalities **asking for their interest** in the process and emphasizing that the process would be based on voluntariness. Eight municipalities in northern Sweden responded positively and two of these were chosen by SKB for test drillings, Storuman and Malå." (page 54).

D4.3 : Case studies reports: in-depth understanding of the mechanisms for effective interaction with civil society: selected case studies

Annex II – Summary Tables

In order to facilitate a comparative analysis, a series of synthetic tables with the main findings on perception and engagement for each country and for each historical period have been elaborated. It is a very schematic synthesis that corresponds to the broader data of the annex II.

Table A.1: Key factors underlying public perception and engagement in Bulgaria, by periods.

BULGARIA	Perceived risks & benefits	Political-institutional factors (shaping social trust)	Socio-cultural factors	Engagement activities
1950 – 1970	*(Neither risks nor benefits have been detailed in the SCR for this period)*	Dependency on the Soviet Union's technology and development model	Nuclear technology as symbol of scientific progress and national pride Some receptors feared to be accused by future generations for supporting nuclear	Secrecy
1970 – 1990	<u>RISKS:</u> Health and safety risks: Related to emergency situations (earthquake, Chernobyl accident): NPP workers' concerns which eventually caused them psychological stress, and also feelings of insecurity and helplessness. Due to the earthquake, the Bulgarian authorities postponed the launch of	The secrecy of information provided by public authorities framed the public perception of the government itself.	The dependency on the Soviet Union's nuclear technology was presented as a symbol of brotherhood between Communist countries	Information flowed but only among selected people close to the government When the Chernobyl accident happened the government did not inform the population about its real scale and consequences, The media did not report the accident, until a year later a TV documentary mentioned the accident and the population

	two additional reactor blocks and demanded additional safety measures. In economic terms, the Bulgarian promoters/regulators expressed their concern about the high cost of the nuclear program.			became aware of its importance <u>PUBLIC-INITIATED:</u> after Chernobyl accident, the lack of any information provided to the public led to protests against nuclear establishments (Ekoglasnost)
1990 – 2015	<u>RISKS:</u> International agencies expressed their concerns with the technical safety issues of NPPs (in contrast with the opinion of Bulgarian authorities) a public committee (Receptors) aimed to engage the public with the problem of the safety conditions of the existing NPP.	Bulgarian promoters/regulators expressed their satisfaction with the technical safety issues, in contrast with the opinion of international agencies. Social trust is shaped by the political fight between pro and anti-European parties, which strongly conditioned the national nuclear agenda The building of a new NPP reactivated the debate on energy (and political) dependency because it might help to diminish the energy imports from Romania and Turkey, while increasing dependency on Russian technology		A research consultation sponsored by the public authorities was used to decide how to proceed with the nuclear sector when joining the European Union A referendum was held in Bulgaria (2013), the question was: "Should nuclear energy be developed in Bulgaria through construction of a new nuclear power plant?" People replied affirmative, but it didn't reach the minimum turnout of 60% to be valid.

Table A.2: Key factors underlying public perception and engagement in Finland, by periods.

FINLAND	Perceived risks & benefits	Political-institutional factors (shaping social trust)	Socio-cultural factors	Engagement activities
1950 – 1970	RISKS: fishermen community fears that thermal pollution would damage the fragile marine ecology the safety culture of the Soviet Union was considered as less exigent than the Western one BENEFITS: bringing employment to rural areas nuclear developments promised better future by enhancing the development of modern industrial Finland the security of energy supply was one of the main arguments to take decisions about nuclear projects, and in Finland this was especially important because much of the country is located in the arctic environment promoters and regulators promised inexpensive electricity thanks to the	Finland became member of the United Nations organization due to its participation in nuclear projects. The diplomatic relationship with the Soviet Union conditioned and interfered some decisions on nuclear programs	difficulty of calculating nuclear risk (distance between experts and lay people) can be found 'unwillingness' to be exposed to risk (as such the case of the residents of the town of Loviisa, where a NPP was proposed key role played by the 'national scientific pride' in justifying the nuclear projects decisions Several municipalities were reluctant to the sitting decision because the project did not fit in its future development plans Threats to local identities were a source of public reactions against nuclear developments the Finnish nuclear program played a political role in the international position of the country The values of the post-war generation included a	decision making on nuclear projects in Finland had been made for long time by a small group of politicians, engineers and corporate managers. Therefore, nuclear energy in Finland could never be a "democratic" decision. public opinion surveys had been used to get knowledge about public attitudes towards nuclear energy in general, or towards the sitting of a NPP

	nuclear power. significant investments had to be made into research and education, and in high quality jobs in order to attract talent of those engineers studying abroad		positive view of technological progress and of nuclear	
1970 – 1990	<u>BENEFITS:</u> the promoters of the nuclear program argued that radiation could be useful for medical healthy uses new reactors to be built were considered far safest than those of TMI or Chernobyl	opposition movements to be critics with the nuclear program appealing to anti-nuclear weapons treaties and laws public authorities in Finland noted the country's dependency on energy imports and that the level of self-sufficiency had dropped since the early 1960s meanwhile the demand of energy continued to grow.	environmental movements promoted energy saving, environment protection and new life-styles grounded in the idea that less consumption required less energy	-
1990 – 2015	<u>RISKS:</u> the anti-nuclear movement put on the table the risk of a nuclear accident in a populated area as that of the capital environmentalists defined nuclear power as a non-carbon-free source of energy But the Finnish parliament decided to support more sustainable and	Finland has a governance system including authorities, nuclear companies and government agencies deciding together in closed cabinets, but having high levels of trust among public opinion The whole nuclear program is justified from the beginning and during several decades as a key factor to ensure energy		-

	environmental friendly energy solutions post-industrial society needs flexible, sustainable energy systems that can respond quickly to the changing needs international prices of electricity have dropped questioning whether nuclear energy is today economically feasible nuclear power stations are capital intensive and investments in nuclear energy are deducted from renewable energy sources. the recent construction of the fifth reactor has been tarnished by delays after delays, and the costs have more than doubled. <u>BENEFITS:</u> radiation is a natural phenomenon and that most of the people are exposed to natural radiation everywhere new reactors are necessary if Finland is going to fulfill its commitments in the global fight against climate change.	independency. The particular geostrategic position of the country during the Cold War, in-between East and West, facilitate the political preferences for an energy source that could guarantee a high degree of energy independence. The energy dependence from the Soviet Union is presented as a reiterate concern some nuclear developments that would help to decrease energy imports (from Russia) and improve self-sufficiency		

	rigorous testing of materials and processes and safety rules imposed by authorities are presented as guaranties of safety. Nuclear development was a way of fighting against the unemployment crisis in the 90's.			

Table A.3: Key factors underlying public perception and engagement in the F.R.Germany, by periods.

F.R. GERMANY	Perceived risks & benefits	Political-institutional factors (shaping social trust)	Socio-cultural factors	Engagement activities
1950 – 1970	RISKS: nuclear energy was criticised by receptors in economic terms focussing overall on the high cost of nuclear waste disposals. BENEFITS: having a powerful nuclear industry was crucial to the country's overall economic competitiveness			the promotion of "research centres" on nuclear issues had been part of the communicative efforts to make technology more acceptable (even among its potential promoters). But it is said that the plan to promote research to generate arguments against critics of nuclear energy worked only in part.
1970 – 1990	RISKS: concerns about the location of the nuclear	lack of trust in government and regulators seemed to be a popular point of criticism among the groups	low controllability of the risks of the technology in the case of a Scientific-technical institute for	PUBLIC-INITIATED: people against the project of building a NPP collected

	installation because of safety issues in the 1970s there was a shift of opinion towards more pessimistic views of the effects of the technology. Regulators developed into a critic of nuclear energy in the 1970s. the interest of Promoters in nuclear development reduced once energy consumption rose slower than expected. Fluctuations in the overall economic context could influence the profitability of nuclear projects regulators do not take the project of a Research institute (Scientific-technical institute for reactor construction - WTBR- and a research centre for limnology) was the high costs their might suppose the commissioning and the further use of complex buildings <u>BENEFITS:</u> nuclear power as a clean and safe energy source that was not involved in	against nuclear energy. Lack of trust in government's willingness to seriously consider people's concerns the proximity of political elections was the main factor that influenced the government to postpone the choice of the place where a NPP should be built	reactor construction (WTBR) and a research centre for limnology regulators considered the commissioning as irresponsible, because the risks were ultimately not calculable being in support or against nuclear power is a matter of how to be seen by future generations: as a traitor or as a hero (identity) the search for a site raised concerns among receptors who demonstrated against the project (land conflicts were related to political territorial borders) locating a repository site in the economically underdeveloped hinterland. The government tried to avoid opposition against the project, which failed because the level of protest increased military aspects of the peaceful use of nuclear power in early West Germany	and submitted 100.000 signatures the opposition against nuclear power has been specially strong and violent, and numerous protests and communication activities coming from opponents were repeatedly organised over the country social movements opposing nuclear installations lodged in court against siting

	any threats for the public (until the Chernobyl accident happened)			
1990 – 2015				

Table A.4: Key factors underlying public perception and engagement in Spain, by periods.

SPAIN	Perceived risks & benefits	Political-institutional factors (shaping social trust)	Socio-cultural factors	Engagement
1950 – 1970	RISKS: (needs of large investments) importance of the financial support that Spanish electric companies (Promoters) received from foreign banks since early times. In this case, the nuclear program was seen as cheaper than expected.	-	-	administrative and legal litigation by local authorities against chosen nuclear locations became the initial strategy in most cases
1970 – 1990	RISKS: concerns about potential radiation released by the NPPs worries about potential water contamination related to a NPP, which would negatively impact agricultural and marine activities	the promoters began building a NPPs without the compulsory reports and official permits. In all the cases the public authorities later legalized those illegal works. The legislation was adapted to the NPP interests generating great distrust among the public (receptors).	territorial/regional identities played a crucial role in accepting or rejecting nuclear projects. In some instances, when the central government or other centralised authority took the location decision, the opposition to nuclear power became a fight for regional identity vs. the central government	The communication flows between the government and the stakeholders were hidden to the public and instead developed through private initiatives and channels classic mass media (newspapers, TV and radio) had been used to announce the intentions of

	worries about safety, especially regarding emergency measures local environmental movements had a negative perception of the economic benefits that the NPP apparently provided, which they saw as conflicting with other activities in the territory the end of the lifetime of the NPP created economic uncertainties in the local population The economic costs had skyrocketed and could not be met. With the moratorium, the utilities got rid of their debts and obtained compensation for the estimated losses incurred from stopping their nuclear projects Nuclear energy became increasingly expensive because more and more safety requirements were demanded, and the oil crises made the construction of NPP much more expensive. <u>BENEFITS:</u> the NPP would increase surrounding temperature	Some cases, Promoters did not tell the truth about their intentions when acquiring land for siting the NPPs the industry created its own rules by manoeuvring within the dictatorship and even ignoring the law in their dealings a political party expressed its anti-nuclear principles but later, when governing, changed opinion and maintained or supported NPPs; and the opposite happened between different territorial levels, even governed by the same political party	(there is a conflict between a rural world which feels forgotten and an urban world that holds the main benefits) many of the anti-nuclear movements are difficult to distinguish from the anti-dictatorship movement (The fact that the main nuclear developments took place during the dictatorship linked symbollicaly this technology to this political regime) there are some perceptions linked to the desire to maintain certain forms of life (such as a rural or fishermen's life) anti-nuclear movements in the Basque Country had to deal with the dilemma of how much to accept that terrorist violence can be useful for its presumably peaceful purposes	Promoters and Regulators of NPPs. Whilst national media was available to them, most of the Receptors instead had only access to local press to launch their mesagges. after the Vandellós I incident (1989) the Promoters began producing periodical news about the decommissioning process, which had also been in some degree publicised and informed through the website (Event 1). In some cases the Promoters held press conferences to present NPP construction projects, and announced in the press the NPP's entry into operation as a way of making the population aware of the irreversibility of the NPP quite a number of public opinion polls have been found (at the national and the local level) since 1978 (not before), but with little consistency in terms of the survey design therefore limiting the possibilities for longitudinal analysis <u>PUBLIC-INITIATED:</u>

	with positive effects for farming and touristic activities the technology is safe and effective. (After an incident) a major catastrophe did not happen due to the effectiveness of the high safety standards applied creation of jobs and the socioeconomic development related to the NPPs, both at local and national levels nuclear energy was necessary for the development of Spanish industry as a whole, as well as for the hosting regions. Promoters warned of the risk of a return to underdevelopment if the nuclear path was abandoned guaranty of energy supply (Showcase), because there are so many electricity demands in the country to meet up			social movements against a NPP collected signatures among university experts, and several times they collected more of half a million of signatures big demonstrations in the street against nuclear projects were going in parallel with terrorist attacks causing human victims and material harms articles and press interventions, books, support of celebrities, intellectuals, lawyers, etc.
1990 – 2015	<u>RISKS:</u> social movements mobilized against a nuclear waste repository argue concern by high	there are cases in which a political change in the local and regional government halted the nuclear plans. In these cases (such as	Promoters showed themselves proud of their knowledge and experience in decommissioning nuclear installations	public authorities published reports on the decision about the siting of the nuclear waste repository in a special

	potential costs to be paid with public resources BENEFITS: potential radiation emissions would be low and without any health risks since the radiation emitted by nature would be higher than that from the Waste Repository In the case of the repository, the Public authorities justified it on the grounds of 'economic diversification' (of a poorly developed rural area), and its stoppage was interpreted as a harm to the whole nation's economy.	those happened in the former period) the relevant issue is that policy makers changed their orientations and decisions towards concrete nuclear developments due to political strategies of the electoral arena, even contradicting themselves and their explicit political principles	Promoters (and some Receptors) of a nuclear waste repository (Event 5) considered that nuclear developments would lead the country to scientific excellence, allowing high level scientific jobs in the area warnings on unequal distribution of risk among territories have been detected, with some areas treated as a landfill of dangerous and/or annoying infrastructures technological colonialism (at international level) and imposition over local society (at national level) were discussed (the notion of "unwillingness" to be exposed to a risk) Promoters and Public Authorities expressed their views that people living near the NPP were coping with similar risks in their everyday life (such as road accidents) in order to minimize its importance. Receptors expressed beliefs about the familiarity of the local communities with the NPP because its	website since 2009, the Promoters enabled a part of some NPP in a visitors centre trying to reach a more interactive communication approach Since 2000 local information committees have been created in all the NPPS, which included representatives of the main stakeholders. These are official participatory bodies. similar bodies (local information commissions) were created by the municipalities. Informative committees and Joint Commissions including mayors, social representatives and regulators were constituted in potential nuclear siting villages (Some environmental movements did not agree with the way in which such committees functioned) (they considered them biased) in the case of the siting of a nuclear waste repository, a participative process was promoted through the voluntary candidatures of

			presence became part of their daily life (as some local governments said, other nuclear facilities had been in the area), or it is considered as similar risk as any industrial facility	municipalities (which had before to approve the candidature by voting in the city hall) PUBLIC-INITIATED: social movements protesting in localities showing interest to host the facilities. Internet social networks (twitter) and website resources used by actors pro and against a nuclear waste repository

Table A.5: Key factors underlying public perception and engagement in Sweden, by periods.

SWEDEN	Perceived risks & benefits	Political-institutional factors (shaping social trust)	Socio-cultural factors (shaping social trust & perceived risks and benefits)	Engagement
1950 – 1970	RISKS: no safety concerns were raised in the early years of the nuclear program, but in the 1960s criticisms both from technical experts and politicians about safety requirements of the reactors arose BENEFITS: social movements	the public debate on atomic weapons was (strategically) neutralized by the regulators and political parties due to the coming elections (political games) national independence of energy supply was an aspect of nuclear development subordinate to the competitiveness or reliability of the nuclear	Among regulators the controversy was based on the purpose for the atomic weapons research. The receptors directly related the development of atomic weapons with their security and also with a perceived increasing risk of war. At the political level people that were in favour of research on nuclear	a study group representing both opponents and proponents of atomic weapons was created, generating recommendations for government policy the influence of some scientists writing articles in newspapers and contacting politicians seemed to have great influence in the decision

	considered that NPPs could have positive environmental impacts (e.g. it would avoid other evident sources of river pollution)	energy sector	weapon argued that this would act as a deterrent by showing the world that the country was capable to build it.	making process (mainly from a perspective of maintaining peace) social movements collected signatures for a plea for a referendum on nuclear weapons; and also for a referendum on nuclear power after the TMI incident
1970 – 1990	<u>RISKS:</u> after learning (from the media) what happened in international incidents like TMI or Chernobyl, the population seemed to be worried about the possibility of accidents. This seemed to increase fears and anxieties among public perceptions. from 1972 onwards a dramatic shift took place and nuclear power was criticized from groups of scientists, politicians and environmental activists. Potential environment dangers were among the factors leading to this growing opposition the economic framework of the nuclear program changed towards a scenario of rising costs	Public authorities opened the involvement of the public in nuclear decisions (referendum), but later decided to continue nuclear expansion	importance for the country in terms of its good position in the international community. (milestone for the country in terms of technological development and the beginning of a new epoch) looking for repository sites involved, at local level, specific protests with a NIMBY emphasis. This was a first step towards a more general critique of nuclear developments, which included the defense of local territories one of the objections expressed by some Receptors was the need to advance towards other energy models based on renewable sources and efficiency measures (a request for a more sustainable development	to cope with the Chernobyl impact on public opinion, the regulators organised and participated in numerous communication activities through the media trying to calm the general public Opinion surveys were used in Sweden to gain knowledge of public attitudes towards nuclear power after the Chernobyl accident An advisory referendum was held in Sweden (1980), partly in response to the TMI accident. Despite the result, a full phase out did not occur information meetings with experts of pro and anti-nuclear issues were organized, sometimes leading to the conclusion

	and availability of different, cheaper energy sources The Receptors that were against the development of atomic weapons were also concerned about the high costs for their development as well as for related research; therefore they rather propose to invest instead in other human activities like development aid <u>BENEFITS:</u> Regarding the impact of Chernobyl: Receptors in favour of nuclear power argued that the technology used in Sweden was very different and safer than the one used in Chernobyl and, therefore, there was no need to revise Swedish nuclear policy Independent experts expressed concerns about the suitability of a nuclear waste repository some Unions argued that a shutdown could increase electricity tariffs But other trade unionists claimed for sustainable growth and renewable energy		model, which refers to alternative worldviews)	of giving up a siting process <u>PUBLIC-INITIATED</u>: social movements collected signatures also for a referendum on nuclear power after the TMI incident the referendum campaign became a mass movement of grassroots activists all over Sweden Protests against a repository by local activists became a process of local mass campaigns but they also erected blockades and stolen materials when Chernobyl accident took place hundred of demonstrations were arranged in many places all over Sweden, with thousand people demanding the phasing out of nuclear projects

	the Public authorities (Regulators included) argued that it would be an enormous economic loss not to use the reactors that had been built or were under construction			
1990 – 2015	<u>BENEFITS:</u> when talking about a competition between several cities for getting a repository, environmental risks became the dominant argument. But Promoters explicitly focused on geology as a key criteria for minimising environmental risks Promoters of a nuclear waste repository gave assurances that they had the appropriate technology to build a safe repository, and that the country had appropriate geological areas to do it job creation, considered as one of the main factors in the negotiations among the municipalities competing to be selected as a repository site		'familiarity with the technology' seems to play a role in the absence of strong opposition, according to the Promoters	Due to past reactions on the suitability of places to host repositories, the Regulators changed their strategy by a more engagement oriented strategy with local municipalities that were willing to host the facility a local referendum was also organized by local politicians in the two municipalities' proposed as candidates to host a nuclear waste repository, and in both places a clear majority voted against it Regulators strived to engage the local receptors in their studies. In the first failed strategy, the two selected municipalities showed a local opposition, but in the two municipalities which already had local power plants, the strategy was successful and many locals were actively involved in deliberations.

				several municipalities competed in hosting a nuclear waste repository in Sweden. The Public authorities sent a letter to all municipalities asking for their interest in the process, emphasizing that the process would be based in voluntariness

Table A.6: Key factors underlying public perception and engagement in the UK, by periods.

UK	Perceived risks & benefits	Political-institutional factors (shaping social trust)	Socio-cultural factors (shaping social trust & perceived risks and benefits)	Engagement
1950 – 1970	RISKS: the population seemed to be concerned about potential chronic health effects from a specific incident releasing radiation a case of released radiation is described (Windscale), including comments on the financial damage generated to farmers and about the compensatory economic measures adopted by the government	Although the Windscale fire (Event 3) had little impact on the nuclear power programme at the time, the combined impact of the incident itself, the government's handling of it, and the secrecy surrounding it, led to a decrease in trust in the institutions involved. This generated notable criticism of the government and changes to the manner in which nuclear power was debated and perceived Nuclear energy offered a chance to reduce British reliance on coal and	the cause of the incident was a "human error by well-trained but unfortunate plant staff", which inform of a weak point on the confidence granted to the controllability of the plant concerns about potential pollution of local food products were raised by the Receptors (conflict between economic activities and land uses in the area) maintaining the country's place at the 'top table' of international politics in	series of government films were published presenting nuclear energy as somewhat necessary for the country's future and showing that Britain was ready to lead the scientific and political world after the Windscale fire concerns raised locally were addressed by public meetings organised by the promoters' staff, as well as in meetings with local farmers concerned about potential risks to their livestock. These meetings provided feedback on the perceptions and

		expensive imported oil amongst concerns of air pollution and a fuel crisis	Cold War times seems to have been the motive for appealing to nuclear weapons early movements started with a growing concern about nuclear weapons throughout the 1950s public reactions were towards the use of nuclear weapons but not on the nuclear power, in a period of public trust on political institutions.	experiences of locally affected people
1970 – 1990	<u>RISKS:</u> there were a pressure on the decision by the growing concerns about the environment from the Receptors side <u>BENEFITS:</u> public Authorities made decisions based on the assumption that British citizens required confidence that their government had chosen the safest available nuclear technology, which, according to its safety standards, turned out to be British nuclear technology	The UK is the country where the Regulators seemed to have been trying to achieve more trust from the public. They emphasized the need of guaranteeing the choice of the safest available nuclear reactor technology		public authorities implemented an intensive advertising campaign in newspapers about alternative reactor types with the aim of generating (supposedly) public confidence Opinions surveys were conducted in the UK to find the degree of public support for new nuclear public inquiries constitute an interesting participative mechanism as it ensures that several viewpoints in conflict are able to be heard <u>PUBLIC-INITIATED</u>:

				the environmental movement Greenpeace staged non-violent protests, blocking at-sea-disposal by the UKAEA using their boat Rainbow Warrior
1990 – 2015	RISKS: Public authorities recognized the need for a large amount of economic resources, and concluded that nuclear power might result an unattractive option due to economics environmental concerns were detected among some Receptors who saw little progress in the solution of nuclear waste management, BENEFITS: some Receptors seemed to agree with a 'reluctant acceptance' of nuclear power because it could help in advancing towards a low-carbon energy system and coping with the climate change challenges growing importance of tackling climate change	some receptors showed a lack of trust in the reactor management performed by private companies following a culture of secrecy. The receptors demanded more public information about power stations, and this was especially the case in local communities affected		an extensive consultation was organised by the regulators in order to address concerns about nuclear energy and provide more information, based on citizen's panels and focus groups, which indicated public acceptance of companies investing in nuclear power PUBLIC-INITIATED: Moreover, receptors led by the environmental organisations did not attend them believing the decision had already been taken.

Table A.7: Key factors underlying public perception and engagement in Ukraine, by periods.

UKRAINE	Perceived risks & benefits	Political-institutional factors (shaping social trust)	Socio-cultural factors (shaping social trust & perceived risks and benefits)	Engagement
1950 – 1970				
1970 – 1990	RISKS: following the Chernobyl accident public concerns with respect to human health arose, together with public demands for compensation for families exposed to radiation Public Authorities (indirectly) recognized the damage for Chernobyl's workers in order to achieve future safety Environmental concerns appeared during this period, allowing a social mobilization with nationalist aims to develop following the Chernobyl accident Independent experts stated that the Public Authorities established an unacceptable threshold in defining the safe situation in polluted areas, avoiding paying compensations, which allowed the State	Public trust seemed severely damaged in Ukraine by the event and the associated secrecy surrounding its consequences and management, which played a key role in the resistance of Ukraine against Soviet rule. However, key changes in the political scene in Ukraine led also to changes of public attitudes towards nuclear power, in the sense that they reacted less once Ukraine was constituted. Regarding how regulators managed information, the receptors perceived a lack of flow of information to act adequately in an emergence status	the Chernobyl case, treated by the Public authorities as "an external enemy that Soviet people must fight" the use of military rhetoric and images was pervasive in the Soviet media at the time. Soviet troops and military equipment were heavily involved in the Chernobyl clean-up and evacuation operations	lack of information flow regarding the Chernobyl accident (general narrative) and even a falsified narrative about how the management was done the reality of the situation was falsified by the narrative provided by public authorities (promoters / regulators). In this case the lack of communication was not on the accident itself but about its serious consequences many experts proposing informational and educational work with receptors as a method to address such mistrust, reflecting the knowledge deficit model of gaining support through the provision of scientific facts to create a better informed public and therefore overcome societal concerns

	and the Promoters to save economic resources but threatened people's lives			a variety of 'information units' were established in many territories after the Chernobyl accident providing information about levels of radioactivity and educating the public on nuclear technology in a broad sense (Event 2), thus, the regulators were making constant press-releases In Ukraine post-Chernobyl surveys about public attitudes towards nuclear power had been also used in order to better understand the protests and the moratorium vote trends <u>PUBLIC-INITIATED</u>: The antinuclear local mobilization from the receptors contributed to the moratorium on the construction and commissioning of new nuclear plants
1990 – 2015	<u>RISKS:</u> environmental activism insisted that completion of two pending reactors lacked economic efficiency	at regulators level, the debate was on the European West-East distrust situation. Ukraine officials were disappointed by the Western partners	anti-Chernobyl protest became part of a broad independence movement. Chernobyl became a symbol of colonial power and fuelled the	In order to achieve a better public image, the Promoters of NPP tried to introduce rules of transparency and accessibility to the nuclear

	as the most efficient to compensate Ukrainian energy system for the closure of the Chernobyl NPP However, some people do not agree very much, thinking that they were still far away from Western European standards <u>BENEFITS:</u> The nuclear Promoters said that the new reactor models were very different from the Chernobyl type, and therefore safer. Promoters stressed the economic viability of nuclear power, requesting an end to the moratorium.	who, according to the Ukrainian side, failed to fulfill their 1995 commitment to assist the country in exchange for closing the Chernobyl plant After Ukraine gained political independence, the perception of the Chernobyl NPP turned from being a sign of colonial domination by Russia into an important source of the electricity production that crucially contributed to the nation's economic survival and independence	independence movement. However, the issue of "reluctant acceptance" for nuclear power like a condition for national survival was raised among receptors (even if the negative consequences of Chernobyl continue to haunt Ukraine)	sites While the information centres expanded and developed new infrastructure and exhibitions, much of this came from local initiatives without common communication strategies directed to outside communities. The information centres of each of 4 operating Ukrainian power stations announce artistic competition every year. Children living within 30 and up to 100 kilometres diameter zones are encouraged to send their works. The drawings seem to circulate quite widely public opinion survey was done in Ukraine to know the support of people to a NPP project a local referendum was held in the towns near a NPP (1994) Several public hearings were organized by regulators and promoters in the villages situated in the vicinity of the proposed NPPs. Ukrainian

				environmental and anti-nuclear NGOs actively participated in these meetings, but some of these movements also organized alternative hearings PUBLIC-INITIATED: environmental activists illustrated the supposed lack of safety of nuclear installations by putting out constant press-releases social movements (Greenpeace) collected signatures against the repeal of a moratorium and the construction of new reactors environmental movements organized anti-nuclear pickets and public roundtables discussing the moratorium (in the 90's), and they also hung a big banner on the cooling towers of a NPP to protest against the future development of nuclear power in the country

Table A.8: Key factors underlying public perception and engagement in the USA, by periods.

USA	Perceived risks & benefits	Political-institutional factors (shaping social trust)	Socio-cultural factors (shaping social trust & perceived risks and benefits)	Engagement
1950 – 1970	RISKS: insurance sector was not able to cover the potential damages in case of nuclear accident, and for that reason the guarantee has to be provided by the state with public money, a trend that started in the 50's and lasts until today. BENEFITS: since the 50's the Regulator (AEC) promoted nuclear power and encouraged the private sector to join in, offering funding to private companies for conducting research and development on proposed reactor designs	Lack of public trust in regulators: first, because in early times the AEC commissioners were fully beholden to military interests; second, the agency looks as it was "captured" by the industry it was meant to regulate. Other sources of distrust were found in the promises made by Promoters and Regulators that later were not fulfilled or turned out to be false. (in the design and construction of the Fermi reactor, and in spite of the reassurances by the scientists that a serious accident could not happen, one did occur).	Importance of the prestige of scientists owing to their success in the Manhattan Project and in role in the unfolding Cold War military-industrial struggle with the USSR the United Auto Workers opposed the NPP (Fermi) because it would endanger Detroit, the auto industry and auto workers themselves (conflict between different economic activities in the same territory, by defending concrete ways of living) in Cold War times being pro or against nuclear energy was sometimes interpreted as being pro or against the national sentiments. For this reason, some cases of early protesters were qualified (and pursued) as communists.	the accident of the Enrico Fermi Atomic Power Plant, Unit 1, was kept secret at the time (1966) regulators and public authorities made during the 50's and 60's a long series of films about nuclear energy, which were seen by millions of people poll surveys on public opinion about nuclear energy were already done in the 50's (showing a large majority of people having no fear of having a plant located in their community). the relatively litigious American legal and administrative system permits interveners to exert influence on the technology assessment processn, and many people have sought to participate in the regulatory process directly through petitions and

				lawsuits. PUBLIC-INITIATED: in the 60's, the public opposition of the Committee Against Nuclear Power Plants eventually influenced the withdrawing of the application for a construction permit of a NPP in New York (Ravenswood project) During these same years public protests were crucial to Preserve Bodega Bay in California (protesters had grown to about 800 members opposing a NPP project
1970 – 1990	RISKS: potential catastrophic impact of nuclear accidents in large populated areas anti-nuclear groups (as such as Friends of the Earth, Critical Mass, UCS) raised public awareness of safety issues substantial cost overruns characterized the building of NPP, and social movements consider	the Regulator (AEC-NCR) was seen as low trustworthy due to several non-congruent behaviour. First, for its supposedly inefficient functioning (in the aftermath of the TMI accident, "the Kemmeny Report indicated the poor oversight and regulatory operations of the NRC") Second, the licensing of the Diablo Canyon NPP revealed the ad hoc nature of the regulators treatment	some environmental movements (such as Abalone Alliance) critized the direct relationship between civilian and military nuclear power	(supporters) the message that nuclear power represents progress has been deployed by images, meanings and messages set forth in TV, newspapers and journals, cartoons, and opinion columns surveys testing the public opinion towards nuclear energy had been reported several times in the SCR substantial majorities of the public still favored

	nuclear projects too expensive. (recurrent design failures and the need to build in redundancies in safety systems multiplies some nuclear projects costs) economic costs caused by the TMI accident, both in terms of total cleanup costs, as well as in terms of the increased budget devoted to regulatory activities in the aftermath BENEFITS: supporters diminishing the importance of radiation impacts on human health	of seismic characteristics the Regulator (NRC) lost a great deal of trust among people when it accepted an industry-sponsored emergency evacuation plan, in a place where geographic and demographic characteristics make it difficult to evacuate safely		nuclear power, even as anti-nuclear referenda appeared on ballots in eight States PUBLIC-INITIATED: one of the first massive public protests against nuclear power gelled around the Diablo Canyon station. Eventually roughly 60 anti-nuclear groups and 30,000 people came together in protest
1990 – 2015	RISKS: Receptors finds that nuclear technology leads to the disruption of nature, and data about environmental impacts were mentioned (i.e. the heated effluent water damage fishes and other aquatic organisms) series of incidents indicates the challenges faced in mastering nuclear technology, assuring the public about safety, and the risks that are reveal in	some critic groups (such as the Union of Concerned Scientists) considered that the license-renewal process "was designed to limit the scope that could be considered, specifically the ability of the public to intervene", growing distrust among some social groups supporters of nuclear energy emphasize the facts that nuclear power will help secure US energy independence		Poll research to test the social support for nuclear energy was also mentioned in the USA SCR PUBLIC-INITIATED: hundreds of activists sent letters asking state officials to oppose restarting Davis-Besse NPP (in 2004). Years later, in 2012, used a skit to protest in front of the NPP

	station operation that may begin from the mundane and move quickly to the near catastrophe opponents to nuclear energy consider that nuclear power is more costly that supporters contend, and that there appears to be great support in Congress for the nuclear sector in spite of the history of cost overruns <u>BENEFITS:</u> the promotion of the nuclear sector was interpreted as a strategic sector that deserves to be subsidized by the state supporters of nuclear energy emphasize the facts that nuclear power does not produce greenhouse gases that contribute to global warming	The "Megatons to Megawatts" partnership provided enough fuel to generate 10% of America's electricity needs (but it could be also interpreted as a way of losing energy autonomy)		